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GEOLOGY AND THE WORLD AT LARGE[1]

I HAVE no new discovery to announce nor shall I follow the precedent of reviewing the history of geology in part or in whole. Rather I shall ask you to step out of the procession and with me watch it go by. In brief, we shall try to see ourselves as others see us. Frankly, the picture is not flattering. To the world at large geology has taken a back seat. She has lost prestige as compared with other subjects of human thought, and is serving neither herself nor the world as she can and ought. I believe the situation is a challenge to geologists to take stock of where they stand and to again get into the procession in a place commensurate with the large human interest of the subject they represent.

For the past eight years my associations have been mainly and very close with men outside the profession—bankers, merchants, lawyers, judges, manufacturers, bakers, butchers and candlestick-makers. Hundreds of these men call me by my first name and have told me how much they don't know about geology and why.

I live in a town where most of the leading men of all professions are conservative, in theology and otherwise. I do not think that they differ greatly from the leading business and professional men of other towns, and I feel that these men would be vastly enriched in their thinking by a clear knowledge of the larger findings of science in general and of geology in particular.

How many members of your home chamber of commerce or your Rotary or Kiwanis or other service clubs, for example, have any clear idea of geologic time, a conception in which years and centuries sink into insignificance that puts human history in its proper setting, or of the vast geologic changes the earth's surface has undergone or of the story of life's marvelous unfolding up the geologic ages as read in the rocks? My own conclusion is that not one in ten of the big men of my town, the men who own the big stores or manufacturing plants, who dominate its politics, who in a large measure have built and made the town what it is, have more than the vaguest idea

[1] Address of the vice-president and chairman of Section G—Geology, American Association for the Advancement of Science, Nashville, December, 1927.

of these things. They are not real and actual to them. They do not affect their thinking.

More astonishing still I am convinced that the average man of culture of fifty years ago had a better knowledge of these things than the man of culture to-day. Then, every person of culture had some knowledge of geology. It was widely taught in the "academies" of that day, using Dana's "Briefer Story," Steele's "Fourteen Weeks," and other works, and, here in Tennessee, Safford's "Elements of Geology." The fascinating writings of Hayden, Shaler and King, the memories of Lyell, the discussions and disputes of Marsh and Cope, were public property. Geology held a leading place in the museums. Some museums had little else than geologic material, partly because of the activity of Henry Ward in supplying this material. We were a new country with little knowledge of our own mineral resources, and the men who explored this new country and told us of its mineral wealth and earth secrets loomed large in public affairs.

To-day geologic text-books have practically disappeared from high schools and only a small proportion of those who go to college are exposed to this line of knowledge, and I am astonished to find how many of these appear to have missed inoculation and have forgotten about all they knew. Apparently, from what I have gathered from them, our text-books have become so largely a catalogue of facts that the great truths have been lost in the multitude of findings.

Individually most of us are so engrossed in the necessary details of our work that we have all but lost sight of these great truths of which the world at large is blissfully ignorant and of which the world is woefully in need. Our work is no longer spectacular as once it was. It is slow, patient, plodding work, as of the research engineer or surveyor. And when our work does lead out into something interesting or thrilling, we feel that the world at large would not understand, and that by the time we had explained the whole matter so that it would understand the thrill would have worn itself out and become only a shiver. So we content ourselves by telling our fellow workers, conscious that most of them are too busy to read our story after we write it.

The result of all this is that the world at large has lost interest and in large measure even lost track of us. In the field we seldom speak of ourselves as geologists but as mineral surveyors, as that designation is at least partly understood, but not geologists. Geology in the minds of most people is associated only with the finding of mineral deposits, water and fossils. We are often classed with the mineral prospector and in the minds of many have faded out with that picturesque but worthy, if usually impecunious, individual. We hear of great foundations and laboratories for the study of medicine, physics, chemistry, archeology and other sciences, and of expeditions to other lands. We see physics and chemistry and perhaps biology being studied in practically all high schools but what of these have we in geology? A few of our museums feature the bones of giant reptiles. But all too many of them have relegated geology to back rooms and galleries.

So to-day when we are faced with the most stupendous problems facing any science we are handicapped by lack of funds and lack of interest. Geology to-day is breaking away from its old moorings, whether for better or worse. Great fundamental problems face us. Is isostasy true, and, if so, what are its causes and laws? Do the continents float around at will? Did Mesozoic time begin 25 or 250 million years ago? How came our mountains to be? Is there likely to come another ice age, a state-wide lava flow, a continental flooding, such as has often occurred in the past? All of these problems are being approached from new angles. The very foundations of the deep are being stirred; but the world at large knows little of it, would not understand it if told, and so has little interest and is not inclined to be sympathetic to our call for help.

I said the world at large needs geology. Let me take a single example. Some time ago biology stirred up a pretty rumpus over a little matter called evolution. Unfortunately, evolution was not content to remain simply a theory of the biologist. It insisted on getting mixed up with geology and astronomy, with physics and chemistry, with history and archeology, with philosophy and theology, and right there is where it ran afoul of a very real opposition; for nearly everybody holds some kind of theologic belief and evolution said that much theologic belief failed to fit the facts. Biology, of course, came back with "Here are the facts, see for yourselves." Unfortunately the biologic facts are a little difficult to display. For example, it is hard to show a man his strange embryonic development before he saw daylight and said "Hello, folks." It is difficult to demonstrate to him his vestigial reminders of other days when he was only a monkey, a reptile or a fish. It is difficult to bring home to him the bearing of the facts of geographic distribution.

On the other hand, geology deals with mountains and mastodons and other big things you can see. The slow seaward movement of the land is common knowledge when attention is called to it. The progress of life as revealed in the rocks can be easily shown in museums. Nearly any one can go out and collect fossils. Seashells or shark's teeth in the rocks form-

ing mountain tops compel the thoughtful consideration of any thinking man. Even Mr. Bryan felt impelled to admit that the world was not made in six days. So clear and so wide-spread is geologic evidence that if properly handled it should not be difficult to convince any one, except a certain unnamed person, of the magnitude of geologic time, of the long and involved series of events that has led up to the present shape of our landscapes, of the unfolding progress of life as revealed in the rocks.

It is my personal belief that the world at large needs to know these facts and that if properly presented they will be accepted and that the acceptance will create an open mind toward other great facts. Believing this, are not we geologists in duty bound to give most serious consideration to the problem of how to make these facts a part of the stock of knowledge of the world at large and his wife and children?

How shall we go about it?

First, I suggest we make geology a science. At present geology is hardly more than a collection of facts and a collection of facts is not generally considered to be a science. To be a science facts must lead to hypotheses, theories, laws, by which we guide our action or predicate future results from present causes. Physics and chemistry have a foundation of laws. But what laws can you find in our geologic text-books?

Second, we need to revamp our text-books and teaching. Even though we are not prepared to state laws, our facts are of different orders of value. To-day our text-books are little more than catalogues of facts, all on a dead level. They are like a variety-store window. We need to inject some high lights, some mountains, some foreground and background, to set out our star performers and turn the spotlight on them, having in mind the value of these facts in the after life of the student.

Third, we need to get together on some of our larger facts. When one of us declares our giant reptiles were here six million years ago, and another says sixty million years ago, what is the world at large to think of us? No two text-books to-day use the same major units for a time scale. Most trades are getting together on codes and standards of practice. Are lumbermen and furnace men any more reasonable or fair-minded than we geologists? There is, I find, a wide-spread belief among the younger geologists that business or the church have nothing on geology for conservatism.

Fourth, it is time to distinguish sharply between public and professional papers and reports. We publish, let us say, 3,000 copies of a report for the public at public expense. We may estimate that five hundred of these go to libraries, five hundred reach men who can read them intelligently, leaving two thousand to go to people who can find neither pleasure nor profit in the average geological report. At least that is the reaction I get from talking to many people I meet in the field who have sent for our reports or those of other surveys. Recently I went over the manuscript of a detailed areal report intended to inform the people of the area covered, or others interested, of its geology and mineral resources. I listed about seventy-five words, most of them used many times, that might as well have been written in Hindu so far as conveying any meaning to most of its readers, enough to destroy a large part of the value of the report and to explain why we have difficulty in getting rid of 3,000 copies, while a writer in another science on our same floor can not supply the demand for his books with five editions of 10,000 each.

Fifth, recognizing that the average scientist is not qualified by temperament or otherwise, as will be testified by any lawyer or judge, to make a simple, appealing presentation of scientific facts, let us honor rather than discourage the man, whether scientist or not, who can and will put our findings in popular form. Federal and State Surveys might well make the popularization of geologic facts an important part of their work. The Pennsylvania Survey is at present running carefully prepared articles each month in the State school journal, planning road signs wherever there are geological features on the highway, taking and making opportunities to give popular illustrated talks wherever possible.

Sixth, contact with some of those who have been active in propaganda against science teaching leads me to believe that science herself or rather a very few of her disciples have been primarily responsible for this state of mind. A study of attempts to pass inhibiting or controlled legislation in other lines of work shows invariably a failure on the part of a few of those to be curbed to play the game fairly. So here I believe the irritating cause has been the unguarded speech of a very few people who publicly expressed their private views, ridiculing the religious beliefs of their students or neighbors. I do not propose a gag for such people, but would remind them, recalling that they live in a land in which eighty-five per cent. of the people are conservative, that this country started out with "a decent respect for the opinions of mankind," and that a large proportion of the leading scientists of the country, while they may have exchanged their old theology for a new, find their science no bar to themselves taking an active part in the religious exercises and life of the day.

In conclusion, I believe geology to-day faces the

task of taking the world at large into its confidence and friendship in a very real way, first by simplifying and popularizing or making fully intelligent to the public, all public, but not professional, reports. Second, by rearranging our geologic facts so as to bring into the foreground and limelight the great fundamental truths that all persons should know and recasting our text-books and teaching accordingly. Third, by striving to change geology from a history to a science, by the correlation of our facts into generalizations and, if possible, into definitely stated theories and laws. Fourth, by eliminating as far as possible all differences of interpretation and statement. Fifth, by encouraging the man who can dress our science up so as to attract and hold the interest of the world at large. Sixth, by following the Declaration of Independence in having "a decent respect for the opinions of mankind." That is the challenge. Will we meet it?

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PURPOSIVE ACTION[1]

IT is the purpose of this address to suggest certain directions in which a mechanistic explanation may be sought for the purposive behavior of animals, which has been by some authorities regarded as a unique phenomenon, irreducible to those laws which govern the rest of the universe.

Since I shall have occasion to speak of the motives or drives underlying behavior, it is not inappropriate to say that the drive which lies back of my present purpose is a hearty dislike of the doctrine of emergent evolution, which was so warmly endorsed at the last meeting of this association by Professor Jennings,[2] the retiring chairman of the Zoological Section. This doctrine, as you all know, holds that from time to time something entirely new emerges in the course of evolution. It is considered to be opposed to the doctrine of mechanism, which holds that from the beginning the material universe has been governed by a set of unchanging laws. Now as I read expositions of the doctrine of emergent evolution, it seems to mean either something with which all mechanists will agree, or something which involves the negation of scientific thinking and a return to more primitive modes of thought. First, it may mean that new phenomena make their appearance from time to time: new chemical combinations, new species of living beings. Who would doubt it? This is evolution: there is no need for the distinguishing adjective "emergent." Secondly, it may mean that new fundamental laws of the material universe have been discovered from time to time. Who would doubt this, or that others may yet be discovered which have been operating from the beginning but which our imperfect methods of observation have not previously been able to detect? Thirdly, it may mean that the fundamental laws of the universe modify each other when they enter into new combinations. Who would doubt it, or imagine that we have yet observed all the combinations of those laws which have existed from the beginning? Fourthly, it may mean that from time to time new fundamental laws of the physical universe have come into existence, and may at any time in the present or future do so. Professor Jennings complains that without emergent evolution there is no fun in experimenting. According to the mechanistic theory, he says, "from a sample of the universe we ought to be able to reason out the rest; the experimenters are those of us who can't"; and he goes on to say that this must naturally make the experimenter feel deeply inferior. But what would cheer the experimenter? The thought that he may at any moment observe a new combination and have the fun of showing that it is really reducible to already known laws? The mechanist gets a good deal of enjoyment from such an experience. Or the thought that he may at any moment discover a law which has been in operation always but has hitherto escaped observation? This is a joy for which the mechanist may always hope. Or is the only possible thrill for the experimenter to be derived from the chance that at any moment a new law of nature may *come into existence* and he be there to see? But what ought to discourage an experimenter more finally than such an expectation as this? He is trying to discover a law of nature, but what if at any moment it may be interfered with by a new one that has come into existence? If the universe can not be relied upon to stay on the tracks, why try to find out where the tracks lie? Professor Jennings sees in emergent evolution the only salvation from the dire practical consequences of mechanism. "Mingle," he says, "this perfect doctrine of mechanism with equal parts of the perfect doctrine of natural selection and you get a potion, a cocktail, with a kick that is warranted to knock out ethics and civilization." But if we believe that new laws of nature may at any moment begin to act, in the paralysis of science that would result from the drinking of *this* cocktail, I would give still less for the chances of ethics and civilization.

The mechanist then believes that whatever may be the ultimate truth of the matter, an inclination to

[1] Address of the vice-president and chairman of Section I—Psychology, American Association for the Advancement of Science, Nashville, December, 1927.

[2] SCIENCE, 65, 1927, pp. 19–25.

assume emergents in the sense of new forces should be held sternly in check. And it is the object of this paper to suggest how one of the emergents, namely purposive action, may conceivably be reduced to the status of a product of already existing forces.

The vitalist holds that living matter is fundamentally different from lifeless matter, and that its distinguishing characteristic is an emergent, namely purposiveness. As one reflects on the nature of a living body, it does seem to be distinguished from a lifeless body by a tendency to resist and compensate for disturbances of its pattern. It is composed of highly complex molecules, and these whether in living or lifeless bodies are likely to fall apart and disintegrate, thus changing the pattern of the whole. But in a lifeless body this disintegration is balanced by no reconstruction of molecules, while in a living body the pattern is constantly being restored. The actual materials of our bodies are constantly leaving us, but the pattern remains and new materials are forced into the same pattern, which is secured by all manner of devices; moreover, when the pattern can no longer be maintained, by all manner of devices its reappearance in offspring has been ensured. What is this that cares so much about its pattern? No wonder that the vitalist posits emergent entelechies, mysterious agencies that occupy themselves with its preservation. But to the mechanist mysterious agencies are too reminiscent of nature deities, earth spirits, and similar relics of the childhood of human thought to be congenial. And, he asks, is it really true that preservation and restoration of the pattern are peculiar to living matter? The atom also has a tendency to restore its pattern; whenever it loses an electron it makes haste to repair the loss. The mechanist would cling to the faith that the preservations and restorations, even the reproductions, of patterns in living organisms can ultimately be traced to the preservation and restoration of atomic patterns. And if it be said that this is merely to ascribe purpose to the atom, or perhaps to the electron, the mechanist will say, "Well and good; put whatever may be necessary into the beginnings of things, but don't be lavish with emergents during the later processes."

But vitalists in the field of psychology, like Professor McDougall, mean by purposiveness in living organisms more than a mere tendency to restore and reproduce the pattern. Professor McDougall means by purposiveness the organism's anticipation of the results of its action; the end is actually the cause of the action. The organism is not forced by physicochemical laws to preserve and reproduce its pattern; the end to be attained produces the required behavior through a type of causality unknown to lifeless matter.

Now the means by which a living organism maintains its pattern may be divided into molecular activities, such as digestion and respiration, and mass activities such as movements of locomotion, seizing of food, and the like. The former are the province of the physiologist; in the latter, which constitute what is commonly called behavior, the psychologist has an interest, and it is to these that I shall henceforth confine myself.

Purposive behavior, in the sense of behavior objectively adapted to secure the continuance of the individual and the species, may be divided into inherited behavior and learned behavior. (We grant, of course, that the two constantly accompany each other). And it has been customary to include under inherited behavior the simple reflex response to a stimulus and the more complicated responses commonly called instinctive. Now the reflex looks mechanical. It seems, that is, to be dependent rather on the external stimulus plus the animal's physiological state than on any purpose in the animal's mind. And in fact Professor McDougall[3] grants freely that the reflex is mechanical, subject merely to the laws of physiological chemistry. This concession lands the vitalist in certain difficulties from which it takes considerable agility to escape. The first difficulty is that the reflex can be modified by learning, which would seem to obliterate any sharp distinction between it and higher forms of behavior, so that if you grant that the reflex is mechanical you will be put to it to show where mechanism ends and purposiveness begins. This difficulty Professor McDougall meets by asserting that the highly modifiable salivary reflex, for instance, is not a true reflex because it depends on the brain. Only behavior that depends on the brain, we then conclude, is purposive rather than mechanical; it would seem that the emergent "purposiveness" came into existence not with living matter but with the brain. The mechanist may indeed adduce, Professor McDougall says, the case of the frog with brain removed which, if it is prevented from wiping off a drop of acid from its skin with one leg, wipes it off with the other. This conduct looks purposive, but does not depend on the brain. Well, perhaps, Professor McDougall conjectures, in frogs and similar lowly animals purposive action does not depend on the brain.

The second difficulty created for the vitalist by the admission that reflexes are mechanical is that instinctive actions, which on McDougall's theory are manifestations of purposiveness, have been regarded as combinations of reflexes. This view of course must be rejected by the vitalist if the reflex is admitted to be mechanical. Instinctive action, the vitalist holds,

[3] "Outline of Psychology," New York, 1923, pp. 51–56.

is not a chain of reflexes but is guided by the idea of its end, as is shown by the fact that the means taken to secure the end is not mechanically fixed, another means being adopted if one means fails, as in the case of the frog just mentioned. Professor McDougall boldly accepts the consequence of this theory, and asserts that on the first performance of instinctive actions, for example, the first nest-building of a bird, the animal is guided by an inherited mental image of the nest; "the power of thinking of or imagining an object not present to the senses is provided in the form of innate mental structure."[4]

Most of us would hesitate to adopt such a hypothesis, and as a matter of fact F. H. Herrick's[5] careful studies of the instinctive behavior of birds, to which Professor McDougall nowhere alludes, indicate that it looks much more like a series of reflexes than like intelligent purpose. Through first-hand observation Herrick concluded that the series of activities beginning with the spring migration and proceeding through mating, nest-building, egg-laying, care of young in nest, care of young out of nest, and fall migration, is subject to disturbances inconceivable on a purposive theory; for instance, egg-laying sometimes anticipates nest-building, the eggs being laid on the ground, or the migration impulse interrupts the last egg-laying and the young are abandoned. In general when anything interrupts the normal course of instinctive behavior, the dislocated combination of acts that results has much more the aspect of machinery out of order than that of baffled attempts to realize a conscious purpose.

I think we may say that when by "purpose" is meant awareness of the object to be secured, the innate behavior of animals shows no satisfactory evidence of it. But if by purpose we mean merely *persistent striving*, the case is different. There does seem to be in the greater part of animal behavior something persistent, which underlies series of individual acts and unites them by a bond other than that of mere external association. This is shown alike in innate and in learned behavior. One of the most important results of experimental work on animals during the last ten years has been the evidence that animals will not learn without a motive; that a rat will not learn a maze with food in it unless he is hungry; and Szymanski[6] has shown that while various other motives, such as those resulting from uncomfortable surroundings or sex stimulation, will produce learning, a rat will run a given maze only under the influence of the motive that made him learn it. Our mistake as mechanists has been in trying to explain learning as an external linking together of separate acts into a series merely by their repetition. Watson's theory that in learning how to get out of a maze the errors are dropped off not because they involve delay in reaching the goal but because they are less frequently performed than the successful movements is probably the last effort of mechanism in this direction, and it is a failure.

The problem before mechanism in dealing with purpose is not merely to explain the association of transitory acts into series, but to furnish a mechanistic explanation of something that *endures throughout the series*. When in ordinary speech we say that a man has a purpose in what he is doing, we mean that there is something relatively constant throughout his course of action, namely awareness of an end, and when we watch animals engaged in instinctive activities, while their behavior shows that they are not aware of the end, it also shows the presence of something that persists until the end is reached. Can mechanism explain this relatively constant and unchanging factor, or must we make use of entelechies, innate ideas, and other regressions into past modes of thought?

Surveying the physiological possibilities, we find among our bodily processes two types of relatively constant and persistent states, not usually thought of as purposive, and offering no essential obstacle to a mechanistic explanation. The first type comprises internal physiological conditions such as hunger, thirst, fatigue and certain states of the sex organs. The second type includes bodily attitudes, due to the continuous innervation of certain external muscles. Compared to actual movements, both internal physiological states and external bodily attitudes have the character of relative permanence. If we can show that they are involved in purposive action, we shall have a possible mechanistic theory of its essential feature.

The inner physiological states present themselves as the appropriate basis for the motives or drives. The physico-chemical equilibrium of the body is disturbed, either by the lack or by the excess of some important substance. While this condition continues, energy is set free and finds a natural outlet in bodily movement. And movement will continue until the condition ceases, either by restoration of the physiological balance or by the counteracting influence of fatigue. If the external situation is one that has been often encountered, the movements may be adapted either innately or by previous learning to rapid relief of the physiological disturbance, and we

[4] *Op. cit.* p. 202.

[5] *The Popular Science Monthly*, 76, 1910, pp. 532–556, 77, 1910, pp. 82–97, 122–141.

[6] *Pflüger's Archiv*, 171, 1918, p. 374.

say that the animal has acted reflexly, instinctively, or according to habit. If such preformed pathways are not opened, the energy of the physiological state discharges into a wider variety of movements; an animal in a new situation such as a maze runs down all the passages and makes all the turnings possible. Experiments indicate that in maze learning it is the movements nearest the "success" that are earliest learned; that is, while the drive, the persistent physiological state, say, of hunger, becomes associated with all the movements that occur while it lasts, it is most strongly associated with those movements that occur nearest its end. To explain why this should be so, the mechanist can appeal to the established laws of association; the drive will naturally form strongest associations when it is itself strongest, and this of course is when it is nearing its end; further, at the beginning of a repetition of the situation the movements made at the end of the preceding series have the advantage of recency. By the prepotency, thus grounded, of the movements nearest in time to the cessation of the drive, it is possible to explain learning by trial and error; but *only through the influence of the drive* which accompanies the whole series.[7]

Thus with no assumption of conscious awareness of purpose on the animal's part we may hope to explain through the persistent influence of drives the organization of movements into new combinations leading to the cessation of the drive. But what about those cases, common in human behavior, where there *is* awareness of purpose? A man, under the influence of a drive which can not at once be relieved, sometimes works off the impeded energy in random movements as an animal does, but it is his human birthright to think the situation out, guided in his thought by the influence of the *idea* of his goal. This is the climax, the crucial point of the contest between vitalism and mechanism for the explanation of purposive action. Here the idea of the end is actually present, though not continuously present, in consciousness, and not only the idea of the ultimate end, but the idea of means to that end. For this state of affairs the mechanist must conceive a physiological basis capable of being explained on physico-chemical laws.

Why should not the mechanist, who of course holds that a definite nervous process underlies the idea of the end, merely say that this nervous process is the cause of consciously purposive action? Because if we can judge the nervous process underlying ideas from the behavior of ideas themselves, they lack that character of *persistence* which is essential to purposive action. Ideas are essentially transitory: it is impossible for one to endure without change for more than a few seconds. They may recur, but they can not last. Introspective observation of the process of consciously purposive action has shown that the idea of the end to be gained, while present at the outset, may disappear many times during the course of the action or thought without interrupting progress towards the end. The attempt to use the nervous substrate of an idea to explain a coherent series of reactions fails for the same reason that the old mechanistic explanation of learning as an external linking of separate and transitory movements fails: in both cases we must have an underlying process to hold the series together. But in consciously purposive action this underlying process must not only be *persistent,* like the uneasiness of a drive: it must be, so to speak, *constant in direction.*

It was said a little while ago that there are two types of bodily processes which possess that character of relative permanence which is needed for the physical substrate of purposive action: internal bodily states, in which class the drive or motive belongs, and external bodily attitudes.

Now if we watch a man who, when he can not get relief from the influence of a drive by immediate action, begins to think the matter out, we observe that he becomes quiet, that his restlessness ceases. If we are that man, introspection tells us that our quiet is not the quiet of relaxation but that of bodily tenseness, especially in the trunk muscles. Whenever this attitude relaxes, the energy of the drive begins again to escape in random movements; we stop thinking and become restless.[8] For all purposive action there must be a persistent inner physiological state of imbalance, the drive. For purposive *thinking,* we may conjecture that this state must discharge its energy not into immediate action, whether useful or merely random restlessness, but into a quiet, tense bodily attitude. And any idea may become a purpose, the idea of an end, if, being first associated with a drive, it becomes associated with this peculiar, persistent attitude of tense quietness.[9]

Not only does this motor explanation of purposive action seem to me plausible, but I believe we can trace in animal behavior a stage intermediate between the adaptation of acts to ends which occurs by random movements and requires only the persistent influence of the drive, inducing restlessness, and that which occurs by thinking the problem out, under the influ-

[7] M. F. Washburn, "The Animal Mind," 3rd edition, 1926, 329–337.

[8] It was Münsterberg who first suggested in his doctor's thesis, "Die Willenshandlung," that the feeling of activity or effort, the will-consciousness, consists of kinesthetic sensations from our bodily attitude.

[9] M. F. Washburn, "Movement and Mental Imagery," 1916, Chapter 8.

ence of a bodily attitude of quiet tension. Many observers of the behavior of animals in learning a maze have noted that they quickly acquire a bodily orientation towards the center, and tend to correct movements that carry them away from this oriented attitude. Similarly with Hunter's Delayed Reaction apparatus, even when the animals were restrained from going to the correct door for some little time after the signal light had been turned off, they succeeded in doing so by keeping their noses pointed during the delay interval towards the place where the light had been. The original stimulus for this oriented attitude is of course external, the light, or the smell of food in the maze; but the orientation seems to be capable of persisting for some time after the stimulus is gone, and to be revived by associated stimuli, as when a dog entering a room looks under the chair where he left a ball. Following our general custom of deriving our terms for abstract relations from terms meaning spatial relations (as when we speak of "straightening out" a mental puzzle), we use the expression "thought *directed toward a goal.*" May not the steadily tense bodily attitude accompanying directed thought be in some sense a relic of the orientation in lower animals of the entire body towards the stimulus that will bring relief from a drive? In the beginning, while the reflex and tropism were adequate modes of behavior, the drive discharged in a definite direction. As the environment became more complex, the drive discharged into random movements of which those associated with the drive in its last and most intense stages tended to survive and become organized into systems. In this process the drive secured the persistence needed for purposive action, but the definite direction of the tropism was lost. Often, however, in animals, part of the energy of the drive goes into the tendency to maintain and restore a bodily orientation towards the goal; while in man, for whose varied activities general bodily orientation is too confining, directed thinking is sustained by a vestige of this general bodily orientation, the tense quietness of the trunk muscles that may persist even when we turn from one position to another.

In explaining, then, the persistent character of purposive action, the mechanist may substitute for the vitalist's mysterious, emergent entelechy, involving something over and above the ordinary physico-chemical laws, the *drive* as a state of unstable physico-chemical equilibrium, underlying all purposive action, and an attitude of steady contraction of the trunk muscles, into which the energy of the drive may discharge and which accompanies the higher forms of purposive action. These suggestions towards a mechanistic explanation of purposiveness have had to be put concisely and dogmatically because of the limits of my time. If they are highly speculative, they are at least, it seems to me, by virtue of being mechanistic, closer to the spirit of science than the semi-personal and animistic emergents of the vitalist.

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THE COLLECTING OF FOLK SONGS BY PHONOPHOTOGRAPHY[1]

Ear analysis of folk music. The traditional method of the anthropologist in collecting folk or primitive music has been an analysis of the songs by ear, whether taken directly from the lips of a singer or from a phonograph record. This subjective method has many serious limitations.

That the ear is inadequate to describe many of the important elements of music is best indicated by the American Negro vocal embellishments, whose description has baffled the keenest ear. The fast changes of the voice lose their original identity when heard, becoming fused in perception. Another difficulty with a subjective analysis is the bias due to past musical experience which deafens the notator to elements foreign to his own music. For example, the European musician holds that American Negro music belongs to his musical system, while the African analyzes out of the great sound complex reaching his ear so much in common with his own music and so little that is not that he draws a natural but opposite conclusion.

Conventional notation. The conventional symbols which have been used by collectors of folk music were devised as a representation of European music. Consequently to use such symbols neglects those factors which might make a folk music distinctive. In Negro music, that part which is characteristically Negro is not found in the stilted notes on the conventional five-line staff, but rather in the twists and slides between the lines.

Measurable records of music. In the fall of 1925 we undertook a field study of Negro music, but instead of using the cylinder phonograph we substituted a portable phonophotographic camera. The voices of Negroes were photographed on motion picture film, by using an optical lever somewhat on the order of Miller's phonodeik.[2] This photographic method shifted the analysis of folk songs from auditory experience to an objective measurable record of the sound wave.

[1] Presented before the National Academy of Sciences, at Urbana, Illinois, October 18, 1927.

[2] Miller, D. C. "The Science of Musical Sounds." Macmillan, New York, 1916.

Phonophotographic theory. The most strategic approach in a description of folk music is an analysis of the sound wave, because it is the connecting link between the singer and listener. Preceding the sound wave there is a series of events within the organism of the speaker, and following it there is another series within the listener. All these events may be related in a causal series.

What we are calling the speech and music causal series consists of two main segments. The first, or expression, segment consists of a description of the speaking or singing experience, of the neural action occurring at the same time, of the muscular action following, and of the sound-wave resulting. The second, or impression, segment involves a description of the sound-wave, the action of an adequate receptor, together with neural action and auditory experience.

The sound wave overlaps each segment or, taking the causal series as a whole, it occupies a central position. For musical purposes it may best be described in terms of four properties, *viz.*, wave-frequency, wave-amplitude, wave-form and wave-recurrence. Each of these properties of the sound-wave may be converted into related aspects of links either way in the causal series. When paired with attributes of the sound heard, wave-frequency may be converted into pitch, wave-amplitude into intensity, wave-form into timbre, and wave-recurrence into subjective groupings.

The sound wave properties may likewise be converted into aspects of muscular action, which in turn may be translated into aspects of neural action. Frequency, for example, is linked with the length, thickness and tension of the cricothyroid muscle. Much of the pairing remains to be accomplished, but at least the possibility of relating aspects of each link in the causal series is established. The research of the next decade in speech and music will probably be centered on the formulation of laws of relationship of the causal series links.

Once such laws of relationship are established, it will be possible from only a knowledge of the nature of the sound waves of primitive music, not only to understand the action of the ear and the nature of the auditory experience in folk music, but also to go the other way in the causal series and state the muscles and nerves involved and their mode of action. The collector of primitive music then gets a possible description of some of the neurology, anatomy, physiology and psychology in the production and reception of primitive music, when he only photographs the sound-wave.

Pattern notation. It is possible to decipher the code of the sound-wave into the notes, rests and signatures on the conventional five-line staff. The best argument against such a procedure when used alone may be inferred from the notation we have adopted as a representation of speech and music shown in Figure 1.

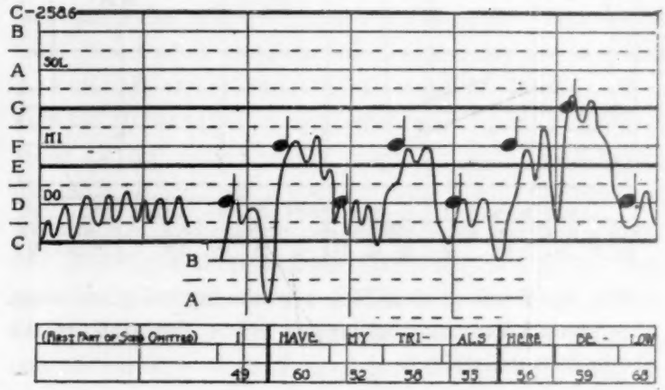


FIG. 1. First part of a Negro spiritual. In the present collection, now in press, there are over thirty folk songs on pattern notation. Leger lines are extended from the staff wherever necessary, in this case the three half steps from B to A inclusive, below the staff proper. The numbers at the bottom of the legend beneath the staff are in terms of .01 sec., representing the duration of a tone.

In this illustration, the graph-curve forms itself into certain definite patterns, which are descriptive of the vocal phenomena of the sound-wave. We are calling this the "pattern notation." The horizontal lines represent a half-step, and the six equal divisions from left to right each have a value of one second. This graph displays only the frequency and recurrence patterns, but wave-energy and wave-form analysis may also be represented.

The distorted and insufficient view of the nature of music revealed by a note-symbol may be seen on the tone "I," Fig. 1. The voice brushes up against the note for a brief time, but the tone begins three half-steps below, and drops rapidly for five half-steps on the release. This type of release is quite common in Negro singing. It seems as if the extended drop releasing "I" were intended to give a running start on the tone following. Then there are the wavy lines at the left of Fig. 1 representing the vibrato, which persist whenever the tone is held for any length of time.

Figure 2 is a sample of a Negro workaday religious song. Here the note-symbol crumbles completely, for many of the tones are entirely intonations. Tones such as *since*, Fig. 2, a glide upward throughout its duration of a quarter-note, suggest that the Negro frequently adds a touch of the dramatic by including speech intonations here and there. The sweeping attacks and releases of tones illustrate how the free-

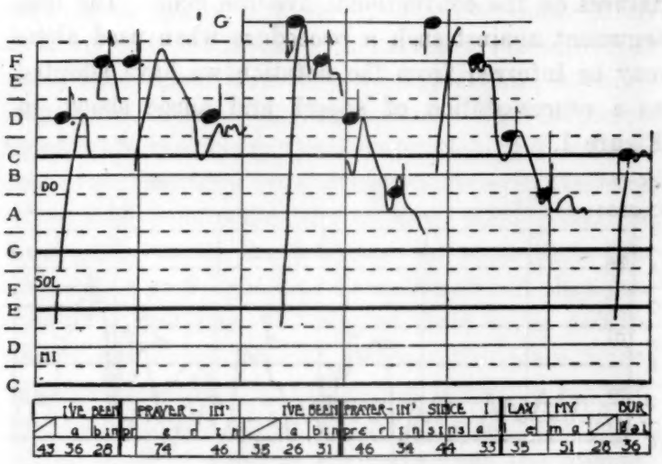


FIG. 2. Section of a Negro workaday religious song. The second line on the legend below the staff is the phonetic transcription.

dom which the Negro enjoys in singing is left intact on the pattern notation.

It is apparent from these examples that no longer need the word "unnotatable" be applied to anything in speech or music.

Negro vocal ornaments. The personal decorations of primitive man are no more tangible than the ornaments of voice, when the latter are brought out by phonophotography. The vocal ornaments may be isolated from a song, classified and placed on exhibit as a particular pattern. With a phonograph record or film to reproduce the music, any one may hear the vocal ornaments which are pictured.

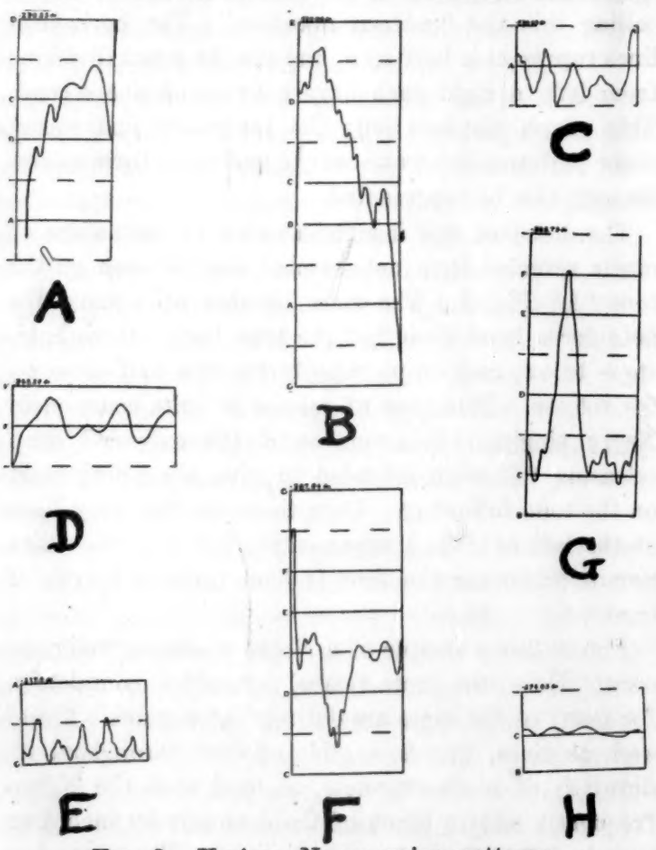


FIG. 3. Various Negro voice patterns.

Such a museum exhibit is presented in Fig. 3. These are close-ups of the pattern notation. *A* represents a Negro attack of a tone, and *B* and *C* releases. The falling intonation at the end of *B* is heard often at the close of a breath-group. The upward flip shown on *C* is not such a frequent pattern, but it is used for variety effect. *D* is a slow quaver, the voice slowly alternating, while *E* is a Negro vibrato. Note the irregularity, for it is characteristic of this pattern among Negroes. The artistic singer much more nearly approaches a smooth curve. *F* shows one variety out of many of the interpolated-tone. The tone is begun and ended on the same pitch and with the same vowel, but a short tone is interpolated somewhere within the limits, sometimes above and sometimes below. *G* is a falsetto-twist, where the voice twists in and out of the falsetto for an instant, giving a peculiar tone coloring. *H* shows an erratic-waver, which is due to the unsteadiness of the vocal cords in holding a tone. There is no definiteness about the wavering as in the case of the vibrato.

Vocal customs. The vocal customs which make one folk music distinctive from another may now be added as a new chapter for the folk-lorist. Some of these customs have been observed by ear, yet even such a factual problem as quarter-tones in various folk music scales is still being debated. By measuring the sound-wave, it is possible to determine all the intervals in given music to a fraction of a vibration, if desired. It follows that the scale of any music existent at the present time may be determined with precision. The interval graph of Fig. 4 is intended

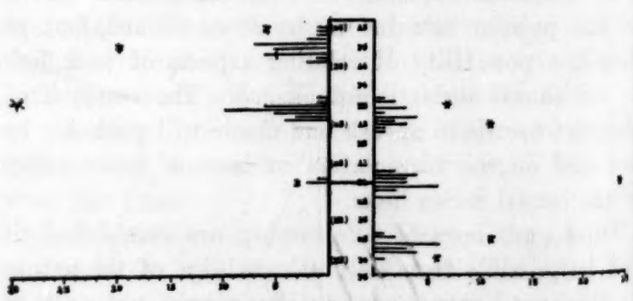


FIG. 4. An interval graph.

to be accessory to the pattern notation, isolating intervals and placing them in compact form for a study of scales.

Another accessory graph, Fig. 5, is the tempo graph. The sudden and expressive speeding up or slowing down of tempo in Negro songs is here illustrated.

Preservation. The many records of folk music lying idle in the museums of America and the *Phonogram Archiven* of Europe in effect are preserv-

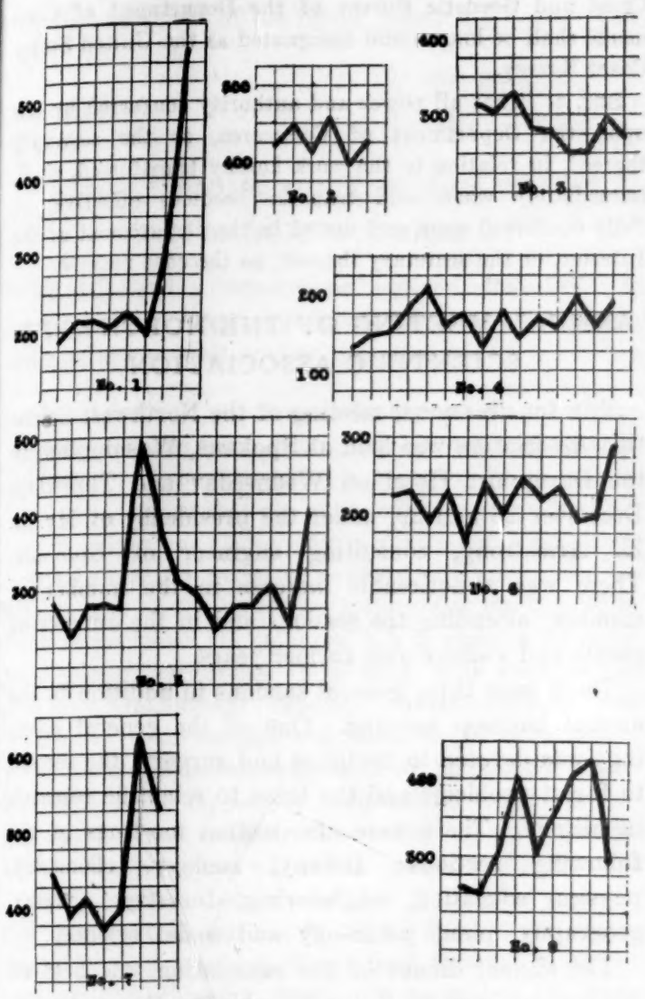


FIG. 5. Some of the tempo graphs of the collection. Vertical values are in seconds, with one square from left to right for each measure in the song.

ing the sound-wave, but not in directly measurable form. The phonophotographic record will not only preserve the sound-wave for measurements, but may use the same waves for auditory reproduction by use of the photoelectric cell.

The cylinder records already collected might be photographed second hand to a profit, now that the announcement of a machine which simplifies the measurements of frequency and recurrence is imminent. There is of course a large error involved in the making of such cylinder records, and the favored method would be to make the record photographic in the original.

MILTON METFESSEL

STATE UNIVERSITY OF IOWA

SCIENTIFIC EVENTS

NEW LABORATORIES FOR THE FACULTY OF MEDICINE AT PARIS

THE Faculty of Medicine of Paris came into possession, in 1920, of a large tract of improved property formerly owned and controlled by the College of Jesuits, rue de Vaugirard, comprising a hectare and a half of land (nearly four acres), which became alienated through the operation of the law pertaining to teaching religious organizations. The property was acquired by the government for 5,500,000 francs and two annuities of 5,000,000 francs each. The Paris correspondent of the *Journal* of the American Medical Association writes that the Faculty of Medicine has decided to establish a hygienic institute and the services of an experimental surgical clinic, under the direction of Professor Pierre Duval. For the latter a gift of the government of Brazil was utilized, which had organized there a model hospital during the war and which turned over to the Faculty of Medicine all its installations and a large amount of material without asking any recompense. But the government has been prevented by the financial crisis from supplying either institution with the 5,000,000 francs promised. Only 1,200,000 francs has been allotted to the surgical clinic. As for the hygienic institute, it still remained, after seven years, in the same condition it was in before. Its director, Professor Léon Bernard, has collected, through various gifts, only 800,000 francs, which has been used for the repairs on these buildings, which had deteriorated owing to their having been neglected over a period of fifteen years. Neither the minister of health nor the city of Paris, nor the general council of the Seine, has sufficient funds, at present, to supply the amount needed, by reason of the creation of overburdensome taxes, which paralyze general activities and yet do not furnish an adequate return, while the high cost of living and the increase of salaries and pensions absorb a large part of the available liquid assets. An anonymous donor has contributed 500,000 francs; the fund into which are paid the levies on gambling, clubs and horse racing has furnished an additional 150,000 francs. With this sum, the buildings that were falling into ruin have been restored and six large laboratories have been built and equipped with the necessary supplies, including suitable quarters for experimental animals. The final results are excellent, but it is claimed that they would not have been possible except for the fact that the Faculty of Medicine was free to dispose of the funds as it chose, whereas if the government had taken charge of the improvements the expenditures might have been twice as great. The architects and contractors granted discounts of from 25 to 40 per cent. on the prices that they demand of the government, which pays their bills only after long delays and innumerable formalities. The new laboratories are intended for the department of physiology, which was very poorly equipped heretofore, and are placed under the direction of Dr. Santenoise. The official dedication took place on Novem-

ber 23, under the chairmanship of the minister of public instruction, although that department did not contribute toward the realization of the project, the actual donor preferring to remain unknown. It is generally assumed, however, that a retired professor of the Faculty of Medicine furnished the funds.

THE PROPOSED TRANSFER OF THE GEODETIC WORK OF THE U. S. COAST AND GEODETIC SURVEY

BILLS to authorize the transfer of the geodetic work of the Coast and Geodetic Survey from the Department of Commerce to the Department of the Interior have been introduced into both houses of the Congress. The bill, introduced into the House of Representatives by Mr. Sinnott and referred to the committee on interstate and foreign commerce, follows:

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, that effective sixty days from the approval of this act, and thereafter, the Geological Survey of the Department of the Interior shall be responsible for the execution of geodetic surveys required by the Federal Government in the interior of the United States, including federal, boundary and state surveys, exact levels, triangulation and transverse, the determination of field astronomic positions and variations of latitude, and gravity observations, precise triangulation and leveling in regions subject to earthquakes, and all seismological observations in the United States including the Territories of Alaska and Hawaii.

SEC. 2. That such civilian employees of the Coast and Geodetic Survey, both in Washington and in the field, as may be engaged in work relating to the geodetic and other activities enumerated in Section 1, shall be transferred, without change in classification or compensation, from the Department of Commerce to the Department of the Interior, as the heads of the respective departments may decide: *Provided*, That any commissioned officer now engaged on this work may be detailed by the Secretary of Commerce to duty in the Geological Survey under the direction of the Secretary of the Interior for such period, not exceeding two years from the time when this Act shall take effect, as the Secretary of the Interior may deem advisable, and any officer so detailed shall be entitled to receive the traveling and other allowances authorized by law for the commissioned officers of the Coast and Geodetic Survey.

SEC. 3. The unexpended balances of appropriations, or allotments therefrom, available to the Coast and Geodetic Survey for said activities, including the appropriations for the salaries of the civilian personnel involved, shall be transferred, in such amounts as may be agreed upon by the Secretary of the Interior and the Secretary of Commerce, to the Geological Survey, and shall become available for expenditure under the supervision of the Secretary of the Interior.

SEC. 4. That after this Act becomes effective, the Coast and Geodetic Survey of the Department of Commerce shall be known and designated as the United States Coast Survey.

SEC. 5. That all power and authority conferred by law upon the Department of Commerce, or the secretary thereof, in relation to the work hereby transferred, shall, immediately when said transfer becomes effective, be fully conferred upon and vested in the Department of the Interior, or the secretary thereof, as the case may be.

ANNUAL MEETING OF THE NORTHWEST SCIENTIFIC ASSOCIATION

THE fourth annual meeting of the Northwest Scientific Association was held at Spokane, Washington, in the Davenport Hotel on Wednesday and Thursday, December 28 and 29, under the presidency of Mr. L. K. Armstrong, consulting engineer of Spokane. There was a noticeable increase in the number of members attending the sessions and in the number of guests and visitors over former years.

There were three general sessions in addition to the annual business meeting. One of the general meetings was devoted to medicine and surgery, the second to forest problems and the third to scientific research in history. There were also section meetings of the following sections: Botany, zoology, chemistry, physics, education, engineering, forestry, geology, geography, plant pathology and social science.

The annual dinner of the association was held on Wednesday evening in the Elizabethan Room, Davenport Hotel. On this occasion the address of the retiring president, President Chas. H. Clapp, University of Montana, was delivered. His subject was "National Resources and World Problems."

The following officers were elected for the year 1928:

President: Dr. E. A. Bryan, president emeritus of Washington State College, Pullman, Washington.
Vice-president: Dean Ivan C. Crawford, State University, Moscow, Idaho.
Secretary-treasurer: J. W. Hungate, State Normal School, Cheney, Washington.

At the business meeting the report of the committee on facilities for research and publication was adopted. This report carried the recommendation that the association take steps to form a corporation jointly with the Eastern Washington Historical Society, the resulting body to be known as The Northwest Institute of Arts and Science. A committee will be appointed by the incoming president for the purpose of conferring with a committee from the Eastern Washington Historical Society, this committee to report to the association for confirmation of the terms of cooperation. The association also passed a resolution favor-

ing the enactment of the forest research bill now pending in congress.

J. W. HUNGATE,
Secretary-Treasurer

RESOLUTIONS ON THE DEATH OF DR. FRANCIS W. PEABODY

THE following resolutions on the death of Dr. Francis Weld Peabody have been passed by the trustees of the Boston City Hospital:

By the death of Dr. Francis Weld Peabody the Boston City Hospital has lost a distinguished member of its staff. As director of the Thorndike Laboratory, which was established to prove that the study of disease and research into its causes was as necessary a function of a municipal hospital as of one privately endowed, his success has become a part of the hospital's history and the Thorndike Laboratory, under his guidance, has occupied a foremost place among institutions of its kind. His scientific imagination, intellectual capacity, mental balance and persevering zeal brought him fame as an investigator, while his generous encouragement of his assistants and his appreciative support of their efforts created an organization which would reflect credit on any hospital. His brief seven years of service not only demonstrated the wisdom of the experiment, but it founded a tradition whose effect can not be lost. His interest never flagged during his long illness, and through it all he remained the directing force. He never lost his sense of values in his enthusiasm for research, and in his relations with his patient he was preeminently the good physician. He healed when it was possible, but always he comforted. He was an eminent teacher for he sensed the difficulties of his students. Never didactic, he showed them the way to solve their own problems. Meanwhile he instilled the highest ideals of the art of medicine. His life was one of steady growth, and ever widening influence. His attractive personality and forgetfulness of self, his sympathy and understanding helpfulness, bound his colleagues to him with the strongest ties of affection. Young men found in him an inspiration, while the older leaders of the profession, in which he had become a master, saw in him the bearer of the torch which they were laying down. His life must be measured not by the number of his years, but by the record of his accomplishments, and by the heritage of his example. His character combined the strong qualities of his New England ancestry, softened by tolerance and charity, and nowhere was it better shown than in the courage with which for months he faced the inevitable end.

The trustees of the Boston City Hospital, in placing on record their appreciation of the high qualities of the man, and of his work, wish to express their realization of the great loss which the community has suffered. They share the sorrow of the multitude of his friends, and extend to his family their heartfelt sympathy.

THE NINTH INTERNATIONAL CONGRESS OF PSYCHOLOGY

AN International Congress of Psychology will be held at Yale University, New Haven, in the late summer of 1929. After eight European congresses, beginning in Paris in 1889, it has been decided to meet in America, following an invitation extended by the American Psychological Association at the time of the Philadelphia meeting a year ago. This having been accepted by the international committee, plans for the conduct of the congress were drawn up by a committee of the association, and these were finally adopted at the recent Columbus meeting.

The control of the arrangements for the conduct of the meeting has been delegated to a national committee of twenty-one psychologists, eighteen of whom, including the three principal officers, were elected by a nominating committee and a formal ballot from members and associates of the Psychological Association. Three further members were coopted by the elected committee and eighteen of the twenty-one members were present at the meeting for organization at the Ohio State University.

At that time other officers were elected, and the general plans for the congress were considered and in part decided. The possibility of meeting consecutively in Cambridge, New Haven and New York with a visit to Princeton was considered, and the relative advantages of different universities, including Cornell and Chicago. Yale University was selected owing to its convenient location, the social advantages of meeting in a smaller city and the recent notable development of psychology in that institution.

It is hoped that there will be a large attendance of foreign delegates from all parts of the world. Plans have been initiated by which as many exchange and other professorships and lectureships, summer-school positions, etc., as possible will be filled that year by foreign psychologists, and it may be possible to arrange lectures and conferences in different cities. This will have the advantage of increasing appreciation of scientific psychology and in the promotion of international information and good-will, while at the same time assisting to defray the cost of travel for foreign members.

The American Psychological Association now has about 600 members and 200 associates, all of whom are professional psychologists. Election to membership requires an advanced degree or its equivalent, the publication of research work of some consequence and under ordinary circumstances a permanent position in psychology. All members and associates of the association are invited and expected to become members of the congress. Others from North America can become

members only by invitation. Invitations will be sent to the leading psychologists of the world and it is hoped that psychological societies in foreign countries will cooperate in the arrangements.

The officers of the congress are:

President: J. McKeen Cattell, New York.
Vice-president: James R. Angell, Yale University.
Secretary: Edwin G. Boring, Harvard University.
Foreign Secretary: Herbert S. Langfeld, Princeton University.
Executive Secretary: Walter S. Hunter, Clark University.
Treasurer: R. S. Woodworth, Columbia University.
Chairman of the Program Committee: Raymond Dodge, Yale University.
Additional Members of the National Committee: John E. Anderson, University of Minnesota; Madison Bentley, University of Illinois; E. A. Bott, University of Toronto; Harvey A. Carr, University of Chicago; Knight Dunlap, The Johns Hopkins University; Samuel W. Fernberger, University of Pennsylvania; William McDougall, Duke University; W. B. Pillsbury, University of Michigan; Carl E. Seashore, University of Iowa; Lewis M. Terman, Stanford University; Edward L. Thorndike, Teachers College, Columbia University; Howard C. Warren, Princeton University; Margaret F. Washburn, Vassar College; Robert M. Yerkes, Yale University.

SCIENTIFIC NOTES AND NEWS

DR. CHARLES GREELEY ABBOT has been appointed secretary of the Smithsonian Institution to fill the vacancy caused by the death of Dr. Charles D. Walcott. Dr. Abbot was appointed assistant director of the institution in 1928, and during the past year has been acting director.

THE Perkin medal will be presented to Dr. Irving Langmuir, of the General Electric Co., on January 13 at a joint meeting of the Society of Chemical Industry, Société de Chime Industrielle, American Chemical Society and American Electrochemical Society. Addresses will be made by Dr. E. Hendrick, Dr. W. R. Whitney, Wm. H. Nichols and Dr. Langmuir.

DR. SIMON FLEXNER, director of the laboratories of the Rockefeller Institute for Medical Research, has been elected an honorary member of the Medical Society of Berlin.

DR. HIDEYO NOGUCHI, of the Rockefeller Institute, has been elected to membership in the Kaiserlich Leopold Deutsche Akademie der Naturforscher, of Halle.

DR. MAX WOLF, director of Heidelberg Observatory, distinguished especially for his originality and activity in observational astronomy, was elected an honorary member of the American Astronomical Society at its thirty-ninth meeting in New Haven. The constitution of the society permits the election of only one honorary member at each annual meeting. There are but five other living honorary members and the last election was made in 1924.

DR. CHARLES D. MARX, professor emeritus of civil engineering at Stanford University, has been elected an honorary member of the American Society of Civil Engineers.

LLOYD E. JACKSON and George H. Johnson, senior industrial fellows of Mellon Institute of Industrial Research, University of Pittsburgh, have been elected to honorary membership in the National Association of Dyers and Cleaners.

THE Journal of the Washington Academy of Sciences notes that on the occasion of his seventieth birthday, August 13, 1927, the honorary degree of doctor of natural sciences was conferred upon H. Pittier by the University of Lausanne, Switzerland, "to distinguish the merits of his work concerning the natural history of Canton de Vaud (Switzerland) and Latin America and to acknowledge his efforts in the promotion of colonial agriculture."

THE court of the University of Wales will confer the honorary degree of LL.D. upon Sir Thomas Lewis, F.R.S., for his distinguished scientific work in medicine, particularly in cardiology; upon Sir Robert Philip, president of the British Medical Association, for his distinguished services to the science and profession of medicine, and upon Dr. H. B. Brackenbury, chairman of the council of the British Medical Association, for his distinguished services to the profession of medicine.

PROFESSOR CALMETTE, subdirector of the Pasteur Institute, has been elected a member of the French Academy of Sciences.

PROFESSOR F. MARES, head of the department of physiology of the medical faculty at Prague, recently celebrated his seventieth birthday and is shortly to retire.

THE title of emeritus professor of pathology in the University of London has been conferred on Sir Frederick Andrewes, who retired from the university professorship of pathology, tenable at St. Bartholomew's Hospital Medical College, last July.

DR. RUDOLPH MATAS, who recently retired from the professorship of surgery at Tulane University Medical School, has been made professor emeritus.

DR. ANSON HAYES, who is leaving Iowa State College at the end of the present quarter to become chief chemist of the American Rolling Mills Company, was the guest at a dinner in his honor given by the members of the chemistry faculty on December 19.

MEMBERS of the staff of the U. S. Bureau of Dairy Industry gave a dinner in Washington on December

16 in honor of Dr. C. W. Larson, chief of the bureau, who resigned on January 1 to become director of the National Dairy Council with headquarters at Chicago.

DR. FRANK BILLINGS has been elected president of the McCormick Institute for Infectious Diseases, and Dr. James B. Herrick, vice-president. Dr. Ludvig Hektoen is secretary. During the coming year the principal subject for research at the institute will be infantile paralysis.

DR. JAMES G. NEEDHAM, professor of entomology at Cornell University, is chairman of the local committee of the fourth International Congress of Entomology which meets in Ithaca from August 12 to 18, 1928, under the presidency of Dr. L. O. Howard.

DR. FRED H. ALBEE, professor of orthopedic surgery at the New York Postgraduate Medical School, has been elected president of the Pan-American Medical Association for the ensuing year and will soon begin a tour of the Latin-American countries in which the association operates.

DR. EDWARD RAY WEIDLEIN, director of the Mellon Institute of Industrial Research, University of Pittsburgh, was reelected president of the American Institute of Chemical Engineers at the recent St. Louis meeting.

AT the eighteenth annual meeting of the National Committee for Mental Hygiene, New York, on November 10, Dr. Charles P. Emerson, dean of the Indiana University School of Medicine, Indianapolis, was elected president; Drs. Bernard Sachs, New York, and William L. Russell, White Plains, were among the vice-presidents elected, and Dr. William H. Welch, Baltimore, continues as honorary president.

DR. C. R. BALL, senior agronomist in charge of the office of cereal crops and diseases of the U. S. Bureau of Plant Industry, has been elected by the American Society of Agronomy as agronomic adviser to the National Research Council.

AT the annual meeting of the Asociacion de Tecnicos Azucarera de Cuba, H. J. B. Scharnberg was elected vice-president of engineering.

THE council of the Museums and Art Galleries Association of Great Britain has elected Sir Francis G. Ogilvie, chairman of the Geological Survey Board, president for 1927–28, in succession to Mr. J. A. Charlton Deas.

DR. A. A. L. RUTGERS, director of agriculture, industry and commerce in the Netherlands East Indies, has been appointed governor of Surinam (Dutch Guiana).

SIR DAWSON WILLIAMS, who will shortly complete his thirtieth year as editor of the *British Medical Journal*, and who before his appointment to that post in 1898, had for seventeen years been connected with the editorial department, has resigned. Dr. N. G. Horner, who has been assistant editor for the past eleven years, will succeed Sir Dawson Williams as editor.

DR. HUGH POTTER BAKER, who was formerly dean of the College of Forestry at Syracuse University, has been appointed head of a new department of the U. S. Chamber of Commerce which will work with trade organizations.

DR. FRANK E. RICE has resigned as chairman of the department of chemistry at the North Carolina State College to join the Evaporated Milk Association.

B. J. NICHOLS, who has been studying under Professor Svedberg at Upsala under a Swedish-American Fellowship, has returned to this country. He has accepted a position with E. I. du Pont de Nemours & Company in their Wilmington laboratory, where he will be engaged in research in colloids.

PROFESSOR ELIAS T. CLARK, of the forestry department at the University of Washington, is being relieved of some of his work at the university to enable him to serve as supervising logging engineer for several timber companies in the state. The courses Professor Clark is giving at the university at present will remain under his direction.

PROFESSOR JEROME J. MORGAN, assistant professor of chemical engineering in Columbia University, plans to spend the spring months in Europe, leaving in January. He will travel through France, Italy, Germany, England, etc., studying the state of the gas industry and other developments in chemical engineering.

DR. ANGELO GALLARDO, Argentinian foreign minister, who formerly held the chair of zoology at the University of Buenos Aires, has arrived in Berlin as the guest of the German government.

DR. ALFRED ADLER, Vienna, will return to New York to give a series of lectures on psychology from February 14 to March 22.

THE address of the retiring president of the Philosophical Society of Washington, Commander James P. Ault, on "Ocean Surveys—Problems and Developments," was delivered at a meeting of the society held in the Cosmos Club on January 7.

DR. WILLIAM A. WHITE, of Washington, delivered his presidential address to the American Psychoanalytical Society at the Waldorf Hotel on December 27.

DR. HANS ZINSSER, professor of bacteriology and immunology in the Harvard Medical School, addressed

the New York Academy of Medicine, January 5, on "The Significance of Bacterial Allergy in Infectious Diseases."

DR. J. A. DETLEFSEN, of the University of Pennsylvania, delivered a lecture to the Academy of Stomatology of the Philadelphia County Medical Society on November 30 and to the New York Society of Orthodontists on December 14 on "Hereditary Constitution *vs.* External Conditions in Dental Problems." The data were based on his studies of the dentures of identical twins.

DR. WILLIAM J. MAYO, of the Mayo Clinic, Rochester, Minn., will read a paper on splenomegaly and Dr. Alexis Carrel, of the Rockefeller Institute for Medical Research, will show one of his new films dealing with some phases of his researches at the next meeting of the Johns Hopkins Medical Society which will be held in the auditorium of the School of Hygiene and Public Health on January 16.

DR. HERBERT MAULE RICHARDS, professor of botany at Barnard College, Columbia University, died on January 9, aged fifty-six years.

DR. WILLIS L. MOORE, professor of meteorology at George Washington University and formerly chief of the U. S. Weather Bureau, died on December 18, aged seventy-one years.

DR. J. HOMER WRIGHT, assistant professor of pathology at the Harvard Medical School, died on January 3, aged sixty-two years.

DR. F. S. LUTHER, president emeritus of Trinity College, and formerly professor of mathematics, died on January 4, aged seventy-eight years.

DR. EDWARD V. D'INVILLIERS, consulting geologist and mining engineer of Philadelphia, died on January 4, aged seventy years.

FEDERAL and state corn borer research programs for 1928 were discussed by agriculturists concerned with the corn borer situation at a conference held at the U. S. Department of Agriculture on January 3. The conference was attended by deans of agricultural colleges, directors of experiment stations and other scientists from 14 states. The program of the department was outlined. The work contemplated falls into six general groups, including: entomology, agricultural engineering, agronomy, animal husbandry, chemistry and soils and agricultural economics.

THE annual meeting of the Northeastern Bird Banding Association will be held on January 19, at the University Club, Boston. A field day is planned at Scituate and Cohasset on January 20.

THE first annual dinner of the Ringer Society was held on December 10 at Jules Restaurant, London, with Dr. Henry Ellis, in the chair. A large company of guests were present. The president delivered the Ringer oration. The society is named after Sydney Ringer, one of the first clinicians to realize the value of physiology and biochemistry applied to practical medicine, and known by his perfusion experiments with the fluid bearing his name.

THE juvenile Christmas lectures at the Royal Institution were delivered by Professor E. N. da C. Andrade on "Engines," commencing on December 29. The general courses of lectures before Easter will begin on Tuesday, January 17, when P. R. Coursey will deliver the first of two lectures on the development of dielectrics for electrical condensers. On Tuesday afternoons there will be six lectures by Professor Julian S. Huxley on the behavior of animals. On Thursday afternoons at the same hour there will be three lectures by Sir William Bragg on Faraday's notebooks; two by Dr. J. J. Fox on optics and chemistry, and two by Group Capt. M. Flack on the physiological aspects of flying. Sir Ernest Rutherford will deliver four lectures on the transformation of matter on Saturday afternoons at three o'clock. The Friday evening meetings will start on January 20, when the discourse will be delivered by Sir William Bragg on photo-electricity. Succeeding discourses will include one (on March 2) on the psychology of the sick, by Sir Farquhar Buzzard, the new Regius professor of medicine at Oxford, and another by the daughter of his predecessor, Miss D. A. E. Garrod, on prehistoric cave art. The discourse on February 3 will be by Professor E. C. C. Baly on photosynthesis, and that on February 17 by the Rev. Dr. E. M. Walker on the university, its ideals and its problems. Other lectures will be given by Professor B. Melvil Jones, Professor E. A. Milne, Sir Ernest Rutherford and others.

COLONEL WILLIAM COOPER PROCTER, president of the Procter and Gamble Company, has announced a gift of $2,500,000 to the Children's Hospital in Cincinnati, to be used to construct a building to house research work in connection with the hospital and to endow a clinic. The proposed research building, which is expected to cost from $300,000 to $500,000, will accommodate an out-patient clinic, laboratory facilities for research, class rooms and living quarters for research fellows. The endowment will provide an income for the employment of fellows, who will be appointed by the board of trustees of the hospital. The endowment also will provide a budget for clinical investigations, laboratory work, social service studies, child welfare investigations and psychological studies.

PLANS for using an endowment given to Battle Creek College by Mrs. Mary F. Henderson, of Washington, as the basis for a nation-wide race betterment movement were announced by Dr. John H. Kellogg at the close of the Third Race Betterment Conference at Battle Creek, Mich. Mrs. Henderson has given to the institution an endowment of $200,000 and a 4,000-acre farm in Missouri in the interest of race betterment. It is planned to make the college a race betterment institution.

THE grass herbarium of the U. S. National Museum has received from the Institut Botanique, Montpellier, France, through Professor J. Daveau, conservator, a valuable package containing duplicates or fragments of specimens of Paspalum. Among them are a good series of Salzmann's collections of Paspalum from Bahia, Brazil, some of Husnot's from Martinique and other early collections not before represented in the grass herbarium.

THE sum of £100 is being offered by the Royal Society for the Protection of Birds for an invention of a portable apparatus for the detection of small quantities of carbon monoxide in mines, to supersede the use of canaries and small wild birds now forming part of the equipment of rescue brigades. All competing essays should be received by March 31

THE *Nation's Health*, which for a few years has been published in Chicago, has been transferred with its contracts, lists, good-will and other assets to the American Public Health Association to be published with the *American Journal of Public Health*.

UNIVERSITY AND EDUCATIONAL NOTES

THE Carnegie Corporation of New York appropriated $2,000,000 and paid more than $4,000,000 on previous grants for the fiscal year ended on September 30, 1927, in support of colleges, universities and other educational organizations, according to the report of its president, Dr. Frederick P. Keppel, which was recently made public. Of the appropriations $831,500 went for educational studies. "Only $84,000" was appropriated for libraries, chiefly for the maintenance of library schools. Other grants included $97,600 for adult education, $150,000 for the Carnegie Endowment for International Peace and $500,000 in encouragement of the fine arts.

ON November 8 the city of Cincinnati, by a majority of 31,000, voted for $1,425,000 for its municipal university, the University of Cincinnati. Out of these funds will be constructed an addition to the power plant, library and recitation hall and a new building for the college of education.

DUKE UNIVERSITY has received from Mr. C. C. Dula, president of the Liggett and Myers Tobacco Company, $200,000 to be added to the university's endowment fund.

AN engineering building, which will be erected at a cost of between $250,000 and $500,000, has been donated to Drexel Institute by Cyrus H. K. Curtis, of Philadelphia.

DR. F. A. WOLL has been promoted to be full professor and head of the department of hygiene in the College of the City of New York.

DR. R. F. RUTTAN, director of the department of chemistry at McGill University, and Dr. A. B. MacCallum, head of the department of biochemistry, have resigned. Dr. J. B. Collip, professor of biochemistry at the University of Alberta, has been appointed to succeed Dr. MacCallum.

M. VILLEMIN has been named professor of anatomy at the University of Bordeaux to succeed M. Picqué.

DISCUSSION AND CORRESPONDENCE

ON THE MECHANISM OF ORIENTATION OF ATOMS IN MAGNETIC AND ELECTRIC FIELDS

WHEN atoms possessing magnetic or electric moments are subjected to a field they are supposed to take up definite quantized directions with respect to the field. Experimental confirmation of this view has been made for the magnetic case in the experiments of Gerlach and Stern, but the mechanism by which the orientation takes place presents serious difficulties which may be briefly summarized as follows. In the absence of collisions and radiation the field, of course, can produce only a precession of the atom about the direction of the field. The experiments of Gerlach and Stern, however, show that the atom comes to equilibrium with its moment in definite quantized directions relative to the field and it does this in a time which is less than 10^{-4} sec. Since no collisions are taking place in the beam the only possible method by which the atom can change its energy to become oriented is by the emission or absorption of radiation. But unless the probability of a transition from a non-quantum to a quantum state is very much greater than between two quantum states this process should take something like 10^{10} sec. according to a calculation by Einstein and Ehrenfest.[1]

[1] Einstein and Ehrenfest, *Zeit. für Physik*, 11, 31, 1922.

This difficulty may be avoided if it be supposed that the oven chamber in which the atoms of the beam made their last collision is subjected to a stray field which is parallel to the deflecting field, for it has been shown by experiments with resonance radiation that a small field (of the order of a few gauss) is sufficient to cause complete orientation in the presence of collisions. Although this solution of the difficulty has been ruled out by Stoner on the supposition that the oven chamber was magnetically shielded yet in view of the fact that only small fields are sufficient to produce orientation and since if stray fields were present they would, from the geometry of the apparatus, have been parallel to the deflecting field, it seems that this cause of orientation should be given more weight.

A striking confirmation of the view that the atoms become oriented by stray fields in the oven chamber is provided by the recently published article by E. Wrede[2] on the deflection of beams of electric dipole molecules in a non-homogeneous electric field. In these experiments the oven, where collisions were taking place, was unquestionably field free and the traces produced by the deflected beam shows that the molecules had no definite quantized direction. We have here, then, a case where the field is unable to produce orientation in the absence of collisions.

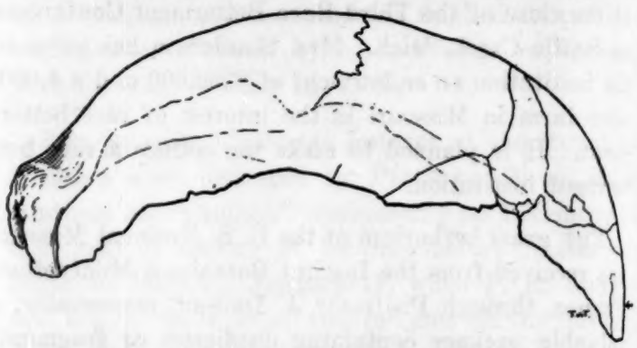
A further test of the ability of the field to produce orientations might be made by a repetition of the Gerlach and Stern experiment, subjecting the oven chamber to definite magnetic fields. For example, if the oven field were at right angles to the deflecting field the orientations produced during collisions, in the case of atoms with a magnetic moment of but one magneton, would be in such directions that no deflection would be produced unless the deflecting field were able to change the orientation.

THOMAS H. JOHNSON
THE BARTOL RESEARCH FOUNDATION
OF THE FRANKLIN INSTITUTE

THE IDENTITY OF CLEAR CREEK SKULL

CONSIDERABLE discussion has occurred in regard to the identification of a calvarium found at Clear Creek near Everton, Arkansas, and purchased by Mrs. Bernie Babcock for the Museum of Natural History and Antiquities, Little Rock, Ark. As there has been unusual publicity concerning the age of this skull, it was necessary to obtain its accurate classification. The specimen was examined by Dr. T. Wingate Todd, professor of anatomy, Western Reserve University, and compared with the remarkable collection of models of the important fossil skulls, together with numerous crania of *Homo sapiens* in the Hamann Museum.

The calvarium (Fig. 1) is obviously that of a

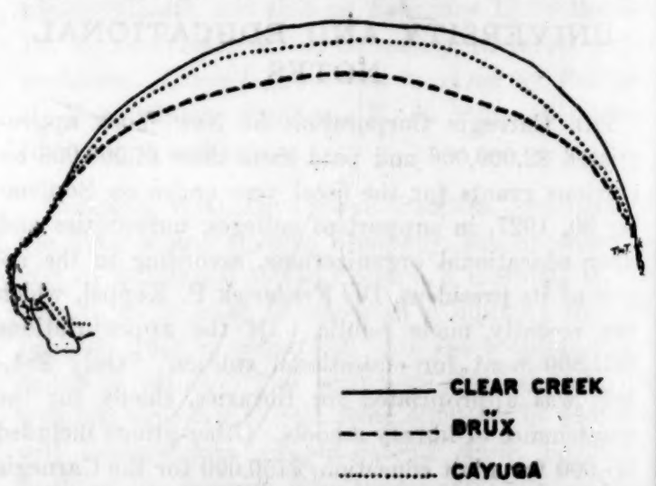


dolicocephalic individual because the cephalic index is approximately 65.4 mm. The large supraorbital ridges proclaim a male, and the union of all vault sutures[1] together with the texture, indicate a man about fifty years of age. The thicknesses of the vault are

Glabellar region	12.5 mm.
Vertical thickness at bregma	7.0 "
Region of lambda	6.5 "
Parietal eminence (approximately)	5.5 "

Compared with corresponding dimensions on the modern male, white cranium, these thicknesses are but slightly greater than those of the average contemporary man.[2]

The supraorbital ridges possess the lozenge characteristics of contemporary dolicocephalic man, whether of white or American Indian stock. There is slight ridging of the sagittal vertex region and slight flattening of the parietal slopes as in primitive



[1] Todd, T. W., and Lyon, D. W., Jr., "Endocranial suture closure; its progress and age relationship, Part 1," *Am. J. Phys. Anthrop.*, 7, 325–384, 1924; and Ectocranial closure in adult males of white stock, Part 2, *Am. J. Phys. Anthrop.*, 8, 23–45, 1925.

Anat. Record, 27, 245–256, 1924.

[2] Todd, T. W., "Thickness of the male white cranium."

[2] E. Wrede, *Zeits. für Physik*, 44, 261, 1927.

dolicocephalic peoples. The dimensions obtainable are

Glabello-inion length	191.5 mm. (?)
Probable euryon breadth	127.5 "
Minimum frontal diameter	94.0 "

In contour the calvarium resembles very closely the people of Cayuga skull (Fig. 2) presented in Morton's volume,[3] which has the following approximate dimensions:

Glabello-inion length	195.0 mm.
Euryon breadth	127.5 "
Minimum frontal diameter	105.0 "

In our calvarium the frontal bone extends rather further backwards on the vault than in the Cayuga skull.

In Hrdlička's excellent résumé[4] the Rock Bluff cranium discovered in 1866 most closely resembles our specimen. The dimensions of this cranium are

Glabello-inion length	195.0 mm.
Euryon breadth	137.0 "
Minimum frontal diameter	97.0 "

Hrdlička's description fits our skull equally well. Its most noteworthy feature, and that which gives it the appearance of a specimen of low type, is its greatly developed supraorbital ridges. These are not in the form of arcs, however, as in anthropoids and in the human skulls of Spy, Neanderthal, etc., and to a less extent in the two Calaveras specimens, but involve, as general among Indians, only about the median three fifths of the supranasal and supraorbital portions of the frontal bone. They project greatly forward, however.

In comparing the profile of our calvarium with that of Brünn[5] we note that whereas the supraorbital ridges of both are equally pronounced, the Brünn specimen has a lower vault and less prominent forehead.

The calvarium is devoid of organic material, but this may well occur within a century of burial. There is no mineralization or other evidences of great antiquity such as would be indicated by relationship to the Conard Fissure material[6] from northern Arkansas.

[3] Morton, S. G., *Crania Americana*, Phila., Plate 35, 1839.

[4] Hrdlička, A., "Skeletal remains suggesting or attributed to early man in North America." *Forms Bull.* 33, of Smithson. Inst. Bur. Am. Ethnol. 30, 1907.

[5] Schwalbe, G., "Das Schädelfragment von Brüx und verwandte Schädelformen." *Ztschr. f. Morphol. u. Anthrop.*, 9, 81–182, 1906.

[6] Brown, B., "The Conard Fissure; a Pleistocene bone deposit in northern Arkansas," *Manual* American Museum of Natural History, 9, 155–208, 1908.

Mrs. Babcock and the Museum of Natural History and Antiquities are to be congratulated upon the zeal which saved this specimen from oblivion, and, although there is no reasonable doubt of its belonging to an American Indian with a head shaped like that of the notorious Cayuga, its primitive character indicates that we may hope to find other evidence of low grade dolicocephalic people in the locality.

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BIBLIOGRAPHY OF COLORIMETRY

IN connection with the work of the colorimetry section of the Bureau of Standards and the report of the colorimetry committee of the Optical Society of America, I am desirous of compiling a bibliography of papers and books having direct bearing on colorimetry, spectrophotometry, and color specifications. It is expected that this bibliography will ultimately be published in the Journal of the Optical Society. It will also be of use in replying to frequent inquiries for information on this subject. In the interest of completeness and accuracy, all authors who have contributed to this subject are requested to send me check lists of their papers giving titles and complete journal references.

The following subjects are mentioned as illustrative of the classes of material desired:

1. Color of daylight and artificial sources. (Spectral distribution of energy, color temperature.)
2. Visual psychophysical data. (*E.g.*, visibility of energy, hue discrimination, saturation discrimination, brilliance discrimination, excitations, abnormal color sense.)
3. Theories of color vision.
4. Methods of computing the trilinear coordinates, dominant wave-length, and purity from data on spectral distribution.
5. Spectrophotometric instruments and methods.
6. Spectral transmission of materials.
7. Reflectance of materials.
8. Colorimeters.
9. Systems of color standards.
10. Applications of colorimetry and photometry to chemical analysis.
11. Turbidity and scattering of light.
12. Color nomenclature and terminology.

Reprints will also be of real service and will be gratefully received. I already have a considerable collection of such reprints. They are classified by subjects, and are of great assistance to those engaged in colorimetric research at the Bureau of Standards. This collection has been profitably used not only by regular members of the staff but by temporary re-

search associates and visitors at the bureau. It is desired to keep it up to date and make it as complete as possible. Authors who have reprints available can very effectively assist in the dissemination of information by contributing copies to this collection, since by consulting it workers on a given subject can find together in one place the pertinent literature, the discovery of which would otherwise require diligent and laborious search through many scattered journals on physics, chemistry, psychology, physiology and sundry kinds of technology.

IRWIN G. PRIEST

BUREAU OF STANDARDS,
WASHINGTON, D. C.

NO METEORITE

ON November 12, 1927, newspapers in the Eastern States carried a New York *World* News Service statement that on November 11 a meteor, accompanied by a bolt of lightning, struck at Fairdale, near Montrose, Susquehanna County, Pennsylvania. The lightning set fire to a building and the meteor made holes 12 to 14 inches in diameter in the concrete highway. Of particular interest was the statement that around these holes in the highway was discovered a strange substance that very much resembled bituminous coal.

The Pennsylvania Geological Survey made inquiry through different channels and received a most satisfactory reply and explanation from H. R. Moffitt, district engineer, Pennsylvania Department of Highways, at Scranton. He writes:

> Lightning struck a barn to which an aerial was attached, running thence to the house and down the ground wire and was apparently conducted through the water that covered the ground at this location, to the pavement. The pavement in several places was shattered along the edge about 10 inches in from the edge and about three inches deep, where the concrete was broken out exposing the reinforcing. The total breaks can be repaired with about one gallon of tar and one hundred pounds of stone. The asphalt crack filler, in several places, was blown out and burned and the material resembled soft coal, which I believe gave rise to the newspaper account of the story.

This note is published so that future catalogs of meteorites will not include this one from Fairdale, Pennsylvania.

R. W. STONE

HARRISBURG, PA.

CONSIDER THE USER OF BULLETINS

IN SCIENCE of December 9, Professor R. J. Barnet, under this cleverly worded title, has given some very good advice to those who control the make-up of bulletins. But he might very justifiably have gone further. Those of us who have to consult the technical and non-technical bulletins of the federal government, of the States and of other institutions, often find fault; and as to the librarians, those long-suffering people deserve our very deep sympathy.

Professor Barnet seems especially annoyed by the difficulty he has had in finding the names of the authors of certain American bulletins, and urges very sensibly that these names be displayed uniformly on the cover page or the title page. My first reaction was the reflection: "Well, after all, we do better than the British." I had in mind especially some of the publications of the Board of Agriculture and Fisheries, the authorship of which I have seldom been able to learn. The beautifully illustrated, but anonymous No. 44 of the "Miscellaneous Publications" of this ministry, entitled "Wasps," pleased me so much that, after a very considerable effort, two years in duration, I learned that it was written by that competent entomologist, R. A. Stenton, now of the Parasite Laboratory of the Imperial Bureau of Entomology at Farnham Royal.

But we must not criticize our British friends while we ourselves are open to criticism. We do not follow the advice of our own best people. As long ago as 1919 the Association of Agricultural College Editors formulated recommendations on the very points brought out by Professor Barnet, and yet they have not been followed by all.

Professor Barnet might have pointed out other things. I have been talking them over with Miss Mabel Colcord, the skilled librarian and bibliographer of this bureau, and from our somewhat different viewpoints we have sympathized about several of these other things. How is one to give exact references with the minimum of trouble when such magazines as *The Scientific American* and *The Scientific Monthly* conceal volume and number in their advertising pages? What is one to do about a repaged reprint (See R. H. Rastall, *Nature*, March 20, 1926, page 418)? Then too, why should scientific men from time to time, as they do, send out reprints or preprints carrying only author's name and the title of the article, with no date and no indication of what it is taken from? Why should the division reports from the various British colonies fail to state the country they represent? Why, in bibliographic lists, should translated titles be given without also the title in the language and the wording of the author? In simple justice to the author, it seems that it should be given as he states it. *The Experiment Station Record* of this department fails in this respect. There are other questions of this kind. They have been discussed, most of them, elsewhere and at various times.

I wish to add one last word, on the desirability of printing the name of the author of the species following the scientific plant or animal name. I labored for years to secure this obviously just custom with one important bibliographical publication before the publishers were convinced of its importance.

L. O. HOWARD

BUREAU OF ENTOMOLOGY,
U. S. DEPARTMENT OF AGRICULTURE

SCIENTIFIC BOOKS

Stars and Atoms: A. S. EDDINGTON, Sc.D., F.R.S., Plumian Professor of Astronomy in the University of Cambridge. New Haven: Yale University Press. London: Oxford University Press. pp. 127.

IN "Stars and Atoms" Professor Eddington has given us one of the most valuable and delightful monographs on astronomy that has ever appeared in the literature of science.

The rapid strides of physics and chemistry into the realms of the stars have fairly bewildered students of the older astronomy, and it is a remarkable service which the author has rendered in giving to the general reader, without mathematical details, the essential problems of modern astrophysics. With a sufficiently extensive description of the atom and its ionization that will enable the general reader to picture the mechanism of radiation and radiative temperature, the author portrays the essential make-up of the sun and stars and makes clear the problem of the maintenance of their heat.

When one reads the all too often dogmatic statements concerning recent advances in astronomy, one feels refreshed in finding so great an authority as Dr. Eddington sounding notes of caution while making sharp distinctions between the demonstrable and the speculative.

The saving sense of humor which relieves the dilemma in many an embarrassing scientific situation keeps the reader in friendly terms with the scientist, even in his wildest guesses and in the end fosters a genuine faith and confidence in results of notable significance.

In few books, indeed, does one sense more acutely the true spirit of science in its never-ending quest for divining the nature of things. From the first chapter to the last the reader is carried at almost breathless pace through round after round of astrophysical discovery till he is introduced to matter in all but unbelievable states as it exists in the companion to Sirius.

In his final chapter on stellar evolution, Dr. Eddington makes a strong argument for the annihilation of matter through the radiation of mass, but does not overlook such technical details and perplexities as the simultaneous existence of giant and dwarf stars in coeval clusters, the problem of devising laws for the release of subatomic energy consistent with the demands of astronomical observations and at the same time reconcilable with any satisfactory picture of the annihilation of matter which the student of subatomic activity can postulate.

A lesser scholar than Eddington would not have closed the book with an anticlimax. It is a mark of genius and modesty worthy of a successor to the traditions of Newton that his closing paragraph should read:

> I should like to have closed these lectures by leading up to some great climax. But perhaps it is more in accordance with the conditions of scientific progress that they should fizzle out with a glimpse of the obscurity which marks the frontiers of knowledge I do not apologize for the lameness of the conclusion, for it is not a conclusion. I wish that I could feel confident that it is even a beginning.

H. T. STETSON

SPECIAL ARTICLES

THE CORRELATION BETWEEN INTELLIGENCE AND SPEED IN CONDUCTION OF THE NERVE IMPULSE IN A REFLEX ARC

THE present paper is a preliminary report of a study to determine if there is any relationship between the factors of intelligence and reflex time or speed in conduction of the nerve impulse in a reflex arc.

My work of the last three years as a fellow of the National Research Council has centered around an investigation of the neural processes in stuttering, and there has developed out of this research a refined technique for utilizing action current measurements in functional neuromuscular derangements. In studying certain reflexes during stuttering among patients widely different in intelligence an apparent relationship between reflex time and intelligence or mental ability was noted. These observations were verified on the patellar tendon reflex. Nearly all the excellent work that has been done on this reflex has involved so-called gross reflex time or the time elapsing between the application of the stimulus and the movement of the foot or thickening of the muscle. This gross reflex time probably would not correlate very highly with such mental factors as we wish to study because nine tenths of the time is taken up by movement of the muscles in extending the foot and any factor affecting the central nervous mechanism

would be masked. Our technique provides a means of determining the length of time elapsing between the stimulation of the patellar tendon and the production of the action currents in the muscles, which is about one tenth as long as the gross reflex time. In other words, it permits the measurement of speed of conduction in a reflex arc.

We secured a group of forty-four individuals ranging in mental ability from feeble-mindedness to that of very superior university men and gave the Otis test of mental ability, Higher Examination, Form A, which has a reliability coefficient of .921. The correlation between the scores on this test and the reflex times was found to be .87 with a probable error of .024. The bright individual has a short reflex time, while the dull individual has a long reflex time. This high correlation is really astounding inasmuch as we are undoubtedly dealing with an imperfect measure of intelligence. Even if the test scores represented absolute measurements of intelligence we could not expect a higher correlation. We therefore took every precaution to verify our findings both on the instrumental side and on the side of intelligence rating. We looked about for other criteria of alertness or intellectual responsiveness and also for a group of individuals which presented a fairly normal distribution of these mental characteristics. Forty-three university freshmen on whom the University of Iowa qualifying examination scores were available were selected to fulfill the above requirements. This examination aims to measure the ability of a student to do college work. The correlation between the University of Iowa qualifying scores and the reflex time again turned out to be .87 with a probable error of .025. The two correlations being equal is an element of chance. The correspondence between the intelligence ratings and the reflex times was very close, not only for widely separated individuals but for the intermediate subjects as well.

The mean score on the Otis of the forty-four subjects was 53.9 as compared to 53.0 obtained on 2,516 college students reported by Professor Otis. The range of our group was from thirteen to seventy-five as compared to the range of his group, twenty to seventy-five.

The mean score of the forty-three freshmen in the university qualifying examination was 362.0, which is approximately the mean of all freshmen students. The range of our group was the same as that of the entire freshman class inasmuch as every tenth student, which included the highest and the lowest, was selected from a list arranged in the order of percentile rank.

The apparatus finally developed to obtain the reflex time in the knee-jerk consisted of a three-stage, resistance coupled amplifier, a portable, three-element oscillograph, a vacuum-tube oscillator, a mechanical stimulating mechanism and a signal circuit.[1]

The amplifier furnished medium amplification and was exceptionally free from inherent disturbances. The oscillograph is manufactured by the Westinghouse Electric and Manufacturing Company. The element which recorded the action currents was approximately ten times as sensitive as the other two standard vibrator elements which furnish the signal and the time lines. A special photographic unit was devised to replace the one with which the oscillograph was originally equipped. This specially built unit will handle four hundred feet of moving picture film.

The oscillator is a General Radio Company product and was used to furnish a time line of a thousand complete cycles per second. The stimulating mechanism described elsewhere[2] delivered blows of constant intensity and at a uniform rate of six per minute. The signal circuit was actuated by discharging a condenser which had been charged previously.

The electrodes were German silver plates, twenty-seven millimeters in diameter, covered with canton flannel, which was soaked in a saturated saline solution before each experiment. One electrode was placed over the place where the femoral nerve enters the rectus femoris muscle which, according to an unpublished study by Tuttle and MacEwen, is half way between the superior margin of the patella and the anterior superior spine of the ilium. The second electrode was placed peripherally about six inches from the first. Control experiments have shown that the amplifier is stable and able to respond instantaneously to changes in potential impressed on the input.

The subjects were comfortably seated, with the thigh slightly elevated to put some tension on the quadriceps muscles. An explanation of the manner in which the experiment was going to be carried out was given to each subject in order to dispel any fears he might have of being shocked or injured. Care was taken also to select individuals who were not fatigued and who had not been ill recently.

Reflex time is determined in a record by ascertaining the length of time elapsing between the instant of application of the stimulus to the patellar tendon and the arrival of the action currents at the first electrode. Reflex times are read and reported in thousandths of a second. At least eight records were obtained on each subject.

[1] Theodore A. Hunter is to publish elsewhere a technical description of this set up.

[2] Tuttle and Travis. "A Comparative Study of the Extent of the Knee-jerk and the Achilles-jerk." *Am. J. Physiol.* 82, 1927, 147.

All reflex time experiments were made and the records read in ignorance of the results from the intelligence tests. Also fifteen records were selected at random and read by a disinterested person. The agreement between the two readings was practically perfect.

The mean reflex time of the forty-four Otis cases was .0194 seconds. The range was from .0114 to .0268 seconds. The mean reflex time of the forty-three university freshmen was .0197 seconds. The range was from .0154 to .0245 seconds.

Each group gave a fairly normal distribution in reflex time. The great individual differences in reflex time are considered as very important. It varied from 11/1000 to 27/1000 of a second. In other words conduction over a reflex arc in one individual was two and a half times as fast as conduction over the same reflex arc in another individual.

These marked differences in reflex times found in our groups are probably referable to differences in synaptic resistances in the arcs and not to differences in resistance of the nerve trunks. Just how much of the nervous system is involved in the patellar tendon reflex is a debated question, but a recent study by the writer[3] showed that the action current records during the knee-jerk were practically identical with those during voluntary extension of the foot. Both sets of records gave indication of two different rates of discharge, one furnishing the audio or principal frequency of from three hundred to six hundred oscillations per second, and the other, the modulating inaudible frequency of from eight to twelve per second. This slower rate of discharge is probably from the Betz cells in the precentral cortex and would indicate that the higher centers are involved in the knee-jerk. If this is true we are dealing with a considerably greater number of synapses than is commonly thought of in this connection and a larger fraction of the nervous system as well.

Although the individual differences in rate of conduction in the reflex arc we have been studying are great they take on real significance when viewed in connection with the complicated associational paths of the cerebral cortex which probably function in the higher mental processes.

We are here confronted with a new fact—a fact which has become available by the refinement of technique in measurement. It challenges us to reinvestigate all the generally recognized phenomena of this particular reflex. It opens up an unlimited vista of inquiries into the nature of its cause, the conditions under which it varies, and its meaning in psychological and physiological terms. It is conceivable that we are here dealing with a relatively complex reflex arc—perhaps more complex than has been suspected, and it is fair to assume that it is typical of a large number of reflex arcs which constitute an integrated central nervous system. Now, according to the best modern theories of intelligence the cognitive processes may be thought of as hierarchies of reflexes of which the vast majority are perhaps at as low a level in the central nervous system as that of the patellar reflex. If this is true, we have in the type of conduction through the patellar reflex arc a sample of the type of conduction that takes place in all well organized motor life and possibly, as these facts indicate, also the cognitive. Tests of intelligence have always stressed the element of speed and this is perhaps right, because an intelligent response to a complex situation may conceivably be thought of as a prompt response, radiating into a large number of systems. We may think of the central arcs of an individual as having a personal equation, just as we do in a gross way when we observe one man is quick and another is slow in his movements, even in his thought movements.

Whatever the interpretation through further study may prove to be, we have in this concept of the rate of conduction through a central arc, a new approach to the neuro-physiology of intelligence or mental alertness.

LEE EDWARD TRAVIS

UNIVERSITY OF IOWA

[3] Travis, Tuttle and Hunter. "The Tetanic Nature of the Knee-jerk Response in Man." *Am. J. Physiol.* 81, 1927, 670.

A COMPARISON OF GROWTH CURVES OF MAN AND OTHER ANIMALS

IN connection with investigations on the time relations of growth of domestic animals, several charts have been prepared on the growth of man. The purpose of this article is to present four of the most striking, or the most instructive, charts together with a few comments. For a background to this work and for details of technique the reader is referred to a series of Research Bulletins which are being published by the University of Missouri Agricultural Experiment Station (Columbia, Mo.).

Figure 1 represents an equivalence chart for growth of man and animals. It represents growth equivalence only for the phase of growth following puberty. This chart serves to illustrate the fact that the difference between the growth curve of man and that of any other animal under consideration is infinitely greater than the difference between the curves of widely separated species of animals. The growth curve of man is, quantitatively viewed, in a class by itself, unless it is found to be related to the curves of other primates. This figure suggests the following comments:

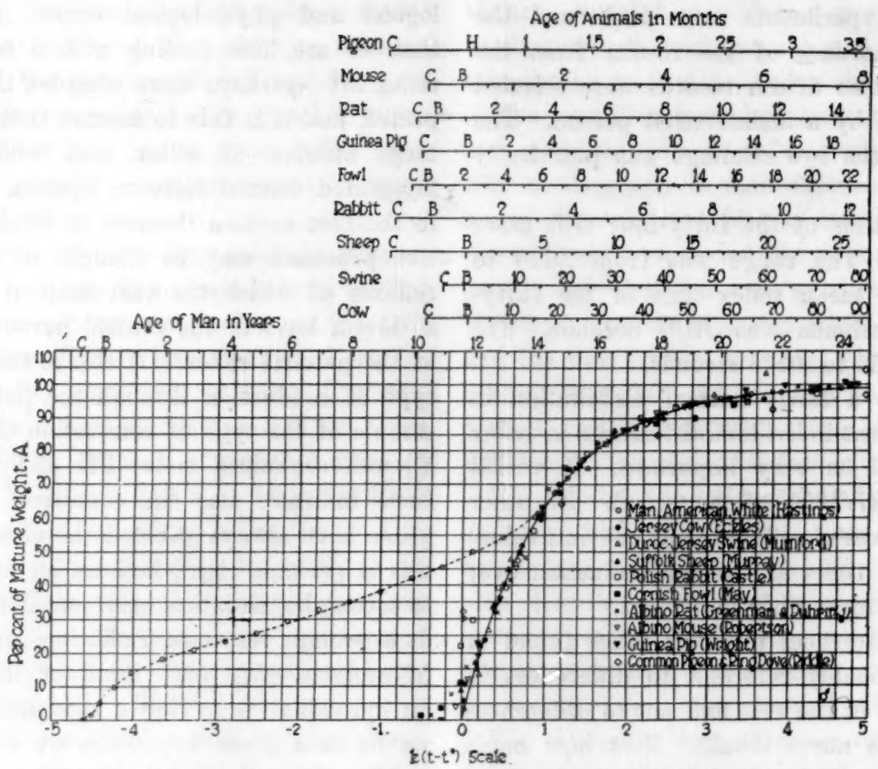

FIG. 1. Growth equivalence during the post-pubertal phase of growth for man and animals. Note that age is counted from birth. For sources of data see Missouri Agricultural Experiment Station Res. Bull. 96 (in press).

1. *The length of the juvenile period.* The length of the juvenile period in man is about 10 years (4 to 14 years). This relatively enormous length of the juvenile period appears to be the most distinguished feature of the growth curve of man.

2. *The position of the pubertal inflection.* In the curve for man, the major inflection (puberty) occurs when the body weight is, roughly, two thirds of the mature weight; in other animals it occurs when the body weight is, roughly, one third of the mature weight.

3. *The post-pubertal phase of growth.* Following the major inflection (puberty) the qualitative course of growth in man and in animals is the same. In both cases the time rates of growth decline by a constant percentage. The numerical value of the percentage decline in the time rates of growth is less, however, in man than in other animals; but the differences are relatively slight. In man it is of the order of 3 per cent. per month; in the sheep, which has the same mature weight as man, it is of the order of 15 per cent. per month. In brief, there are no radical quantitative or qualitative differences between the growth curves for man and other animals during the phase of growth following puberty.

4. *The pre-pubertal phase of growth.* The course of growth during the juvenile, and probably fetal, period of growth is probably qualitatively the same in man and in animals. The time rates of growth tend to increase at a constant percentage rate. There are, however, considerable quantitative differences in this respect. The relatively enormous length of the juvenile period in man as compared to that in animals has

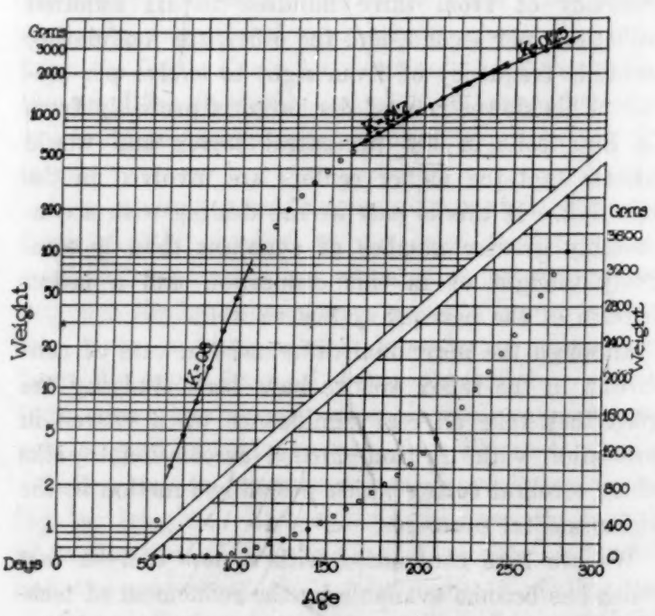

FIG. 2. The course of prenatal growth in man as plotted on arithlog and arithmetic scales. During the third month the rate of growth is about 8 per cent. per day. During the three months preceding birth, the rate of growth varies from 1.7 to 1.3 per cent. per day. The chart was plotted from data published by G. L. Streeter, Carnegie Institution of Washington, Contributions to Embryology, 1920, ix, 143.

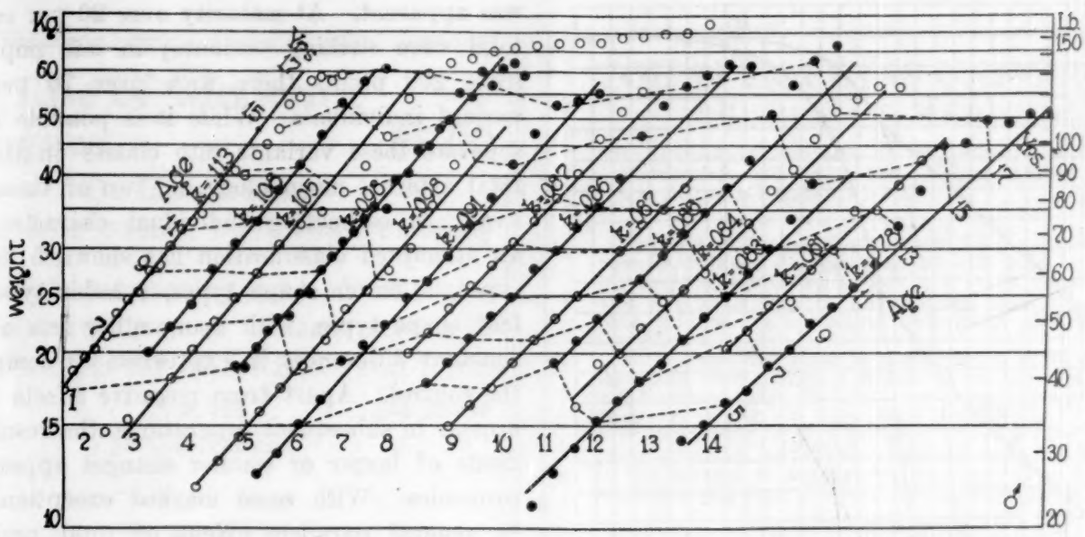

FIG. 3. Chart on an arithlog grid to illustrate the facts that (1) the percentage rate of growth is approximately constant between 4 and 14 years; and (2) that the pubertal acceleration is related to the percentage rate of growth during the earlier phases of the juvenile period. 100 k represents the percentage rate of growth per year. The curves are arranged in a descending order of the values of k. On the left, where the numerical values of k are high, there is no increase in the percentage rate of growth at 12 years; indeed, in curve 1, there is a decrease in the percentage rate at this time. On the right, where the numerical value of k is low, there is a very conspicuous pubertal acceleration. The pubertal acceleration may, therefore, be related to the nutritional condition of the child. For the sources of data see Baldwin, B. T., *The Physical Growth of Children from Birth to Maturity*, Univ. of Iowa Studies in Child Welfare, 1921, 1, 188. Curve 1 represents well-to-do American children (column 1 in Baldwin); curve 2, German (column 106); 3, English (c. 54); 4, American (c. 3); 5, French (c. 76); 6, Italian (c. 122); 7, American (c. 39); 9, English (c. 66); 10, German (c. 79); 11, Russian Jews (c. 120); 12, Japanese (c. 127); 13, Russians (c. 115); 14, Japanese (c. 129). The broken lines on the chart connect the points of the same ages.

already been mentioned. Another difference relates to the percentage rates of growth. In man, the percentage rate of growth during the juvenile period (4 to 14 years) is of the order of 0.03 per cent. per day (10 per cent. per year); in other animals, it is of the order of 3.0 per cent. per day (1,000 per cent. per year).

In the fetal period, too, the percentage rate of growth in man is unusually low. Figure 2 shows it to be of the order of 8 per cent. during the three months preceding birth. In the rat, we have found the rate of growth for nine days preceding birth is of the order of 53 per cent. per day. The difference, however, is not so great as for the juvenile period. Again, it is the juvenile period which, quantitatively considered, is the most conspicuous feature of the growth curve of man as contrasted to the growth curve of animals.

5. *The infantile period.* In addition to the juvenile period, the infantile period in man is conspicuous by its differences from the corresponding segment of the growth curve in animals. It appears to show an inflection similar to the pubertal inflection in the curves of animals; but the inflection proves to be abortive. Sometimes between 2 and 4 years after birth the declining time rates of growth are changed into increasing time rates of growth, and practically constant percentage rates of growth. This constant percentage rate of growth often lasts until 15 years. It is this turn of events which principally differentiates the growth curve of man from that of animal.

6. *The pubertal acceleration.* In children there is often an increase in the percentage rate of growth between the age of 12 and 14 or 15 years. Such an acceleration has not been definitely encountered in the growth curves of domestic animals. This acceleration, however, can not be said to constitute a qualitative genetic difference between the growth curves of man and animals, for it is not a universal feature of the growth curve of man. This pubertal acceleration appears to be related to the percentage rate of growth between 4 and 12 years. If the percentage rate of growth for a given group of children is relatively low during the earlier ages, then there is usually an acceleration between 12 and 15 years; if it is high, there is no acceleration. The pubertal acceleration, when present, appears to be in the nature of compensatory growth for an earlier deficiency. Figure 3 illustrates this statement.

It should be said that growth in length takes place at an approximately constant *time* rate when growth in weight takes place at a constant *percentage* rate (Fig. 4). This is evident from geometrical considerations when growth in length is strictly terminal. It is also evident from physiological considerations; con-

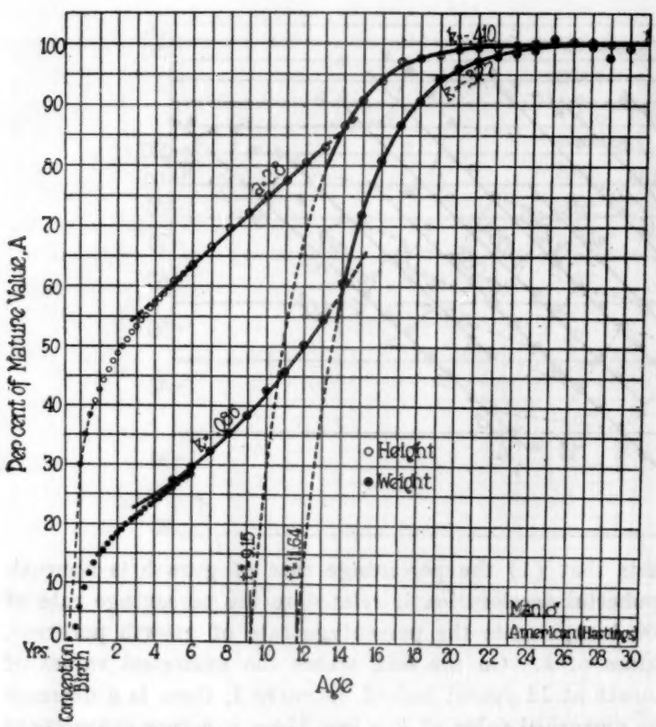

FIG. 4. Weights and heights of man at different ages expressed as percentages of the mature values. While growth in weight between 4 and 14 years takes place at a constant percentage rate (8.6 per cent. per year) growth in height takes place at a constant time rate (2.8 units per year). Data cited by Baldwin.

stant percentage rates of growth in volume and constant time rate of terminal growth both imply that the physiological environment with respect to the growth-limiting process remains constant.

SAMUEL BRODY

AGRICULTURAL EXPERIMENT STATION,
UNIVERSITY OF MISSOURI

PROGENIES FROM X-RAYED SEX CELLS OF TOBACCO

IN January of this year two greenhouse plants of *Nicotiana tabacum* var. *purpurea* (U. C. B. G. 27014)[1] in full flower were exposed to moderately hard X-rays. Immediately thereafter all open flowers were removed and the remaining buds trimmed to a series of size classes. Within 48 hours all buds except those in which pollen was formed had fallen. In these larger buds the primordia of female sex cells had been set apart and in the majority the megaspore mother cells were in meiotic prophases or divisions. Seed from 7 capsules produced by selfing the flowers from these larger buds have given some 1,000 plants, which began to flower in July.

At the seedling stages the presence of variant plants was apparent. At maturity over 20 per cent. of the total were striking variants; in one population of some 200 plants there were over 70 per cent. of variant individuals. While it is possible roughly to separate these variants into classes on the basis of total external morphology, no two of them are identical. In estimating individual character contrasts an attempted classification has shown 5 flower color types, 8 flower shape types, 6 habit types, and 10 leaf shape types, with many other less obvious but constant differences in expression as compared with the control. Apart from recessive effects which may appear in subsequent generations, the results of hundreds of larger or smaller changes appear in these progenies. With some marked exceptions, fertility in general parallels extent of total variation—the more abnormal, the more sterile. However, only a very few individuals, if any, fail to produce at least a few viable eggs.

Detailed cytological examination of a number of variant plants indicates (a) that they often are $2n = 48$ as in the control—*i.e.*, that the variants are not solely the result of a disturbance of the meiotic distributional mechanism; (b) at diakinesis, P. M. C. may show lack of ability to pair on the part of one or more pairs of chromosomes, indicating that some decided genetic modification has occurred; (c) that occasional production of 2n pollen grains occurs, possibly as a result of failure of cytokinesis in the archesporium; (d) that their somatic tissues may show nuclear and other abnormalities equivalent to those often described as following irradiation of somatic tissues and thus suggesting that these latter effects may be solely the expression of initial nuclear modification and possibly heritable.

Progenies from these populations and from subsequent X-raying of *tabacum* and other *Nicotiana* species are being grown. Special attention is being given to effects of irradiation on mature pollen, since with such material the X-ray technique may be standardized and simplified. Despite the absence of direct evidence of the heritable nature of the effects produced, the extent and character of the variations in hand, the fertility relations displayed and the cytological information obtained suggest that data, in the case of a plant of economic importance, confirming the results of Muller's X-ray experiments, may be forthcoming.

It is interesting that two similar efforts, one on the animal and the other on the plant side, to accelerate evolutionary processes should have been carried on simultaneously.

T. H. GOODSPEED
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[1] This variety has been grown here in the pure line for many years and has been subjected to genetic and cytological examination in many intra- and interspecific hybrids (*cf. Univ. Calif. Publ. Bot.*, vols. 5 and 11).

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The main features are outlined of the present state of knowledge of the constitution, dimensions, motions and distribution in space of the stars and nebulae. Since books on astronomy quickly become out of date, the author has appended bibliographical notes indicating where will be reported the results of future investigations.

SCIENCE NEWS

Science Service, Washington, D. C.

ADVANCES IN MEDICINE IN 1927

THE 1927 Nobel prize for medicine was awarded Prof. Julius Wagner-Jauregg, of Vienna, for his treatment of paresis by inoculation with malaria.

Cancer in the chicken can be rendered inactive by small quantities of aluminum and calcium salts, according to Mrs. Margaret R. Lewis and Dr. Howard B. Andervont.

A "heart hormone," or internal secretion that stimulates the heart to keep it beating, was discovered by Dr. Ludwig Haberlandt, of the University of Innsbruck.

Thyroxin, the hormone of the thyroid gland, was made synthetically in the laboratories of University College, London, by Dr. C. R. Harington and Professor George Barger.

Dr. J. J. Abel, of the Johns Hopkins University, has prepared a crystalline insulin which appears to be a pure hormone necessary for the maintenance of normal sugar metabolism.

"Synthalin," a German preparation designed to supplement or replace insulin in the treatment of diabetes, was at first widely hailed, but proved a disappointment.

Discovery of a new drug, "myrtillin," as a valuable treatment for diabetes was announced to the American Medical Association, by Dr. Frederick M. Allen, of Morristown. N. J.

Liver extract can be used to cure pernicious anemia, Drs. George R. Minot, William P. Murphy and E. J. Cohn, of Harvard University, announced; also the latter extracted from liver an extract which produces red corpuscles which is probably the active ingredient.

A diet that simulates a condition in the body brought about by starvation, has been found by Drs. F. B. Talbot, K. M. Metcalf and Margaret E. Moriarty at the Massachusetts General Hosiptal in Boston, to give very successful results in treating epileptic children.

Vitamin C, the substance that wards off scurvy, is present in milk as well as in the fresh vegetables usually relied on to supply it, was the report by Professor L. F. Meyer, following extensive experiments at the University of Berlin.

Ergosterol was declared to be the really active and essential substance in the antirachitic vitamin, by a number of investigators working independently of each other.

Dr. Alfred F. Hess, of New York, reported that dried milk that has been treated with ultra-violet light is the most practical of the irradiated foods that have been used to prevent rickets in babies.

Preventive vaccination for smallpox and typhoid, large quantities of quinine and elaborate mosquito control measures contributed to checking outbreaks of disease epidemics in the South after the Mississippi flood.

Drs. E. G. Wakefield and W. W. Hall, of the U. S. Navy Medical Corps, completed a systematic survey of heat injuries and one of the first investigations into the physiological reactions underlying sunstroke.

Scientists at Berlin have shown that it is possible to change simple embryonic tissues into malignant tissue by exposing the former in tissue cultures to the action of arsenic.

Discovery of the germ causing trachoma, a serious disease of the eye that has been especially troublesome among the Indians, was announced by Dr. Hideyo Noguchi, of the Rockefeller Institute, N. Y.

A curative antitoxin for erysipelas, first developed by Dr. K. E. Birkhaug, of Rochester, N. Y., has been tried out with highly successful results at the Bellevue Hospital in New York, which has one of the largest erysipelas clinics in the world.

Streptococcus germs isolated from skin lesions of erysipelas are capable of causing sore throat without any skin affection, it was found by Drs. George F. and Gladys H. Dick, at the John McCormick Institute for Infectious Diseases.

Progress in the work of developing a serum to fight the African sleeping sickness was announced by Dr. William H. Taliaferro, of the University of Chicago.

A color test for tetanus and diphtheria toxins has been worked out by Drs. Lucy Mishulow and Charles Krumwiede, of the New York City Health Department, that will greatly speed up the commercial production of these products. Hitherto toxins have had to be tested out on live guinea pigs, a time-consuming and not altogether accurate procedure.

Dr. Florence B. Seibert, of the University of Chicago, has produced an active protein in crystalline form which represents a step nearer the solution of the actual chemical nature of tuberculin.

Statistical evidence that the first-born child in a family is more likely to have certain malformations of mind and body than later children, and that such malformations are not likely to recur in later births in the same family, was presented by Dr. G. F. Still, professor of children's diseases at King's College, London.

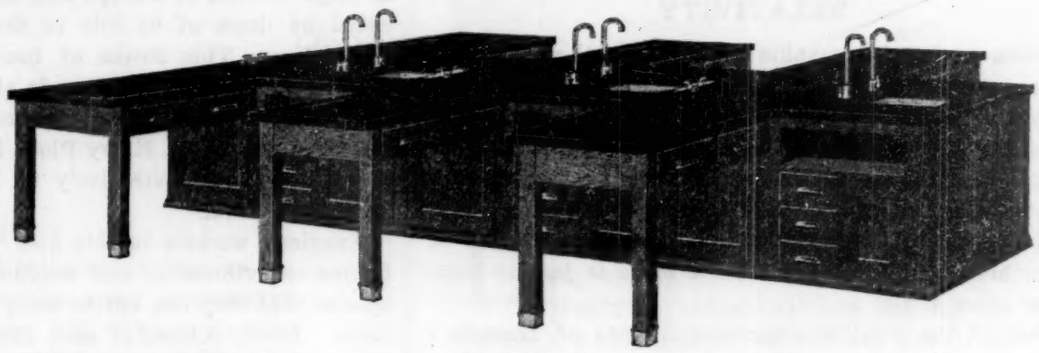
The utility of X-ray photographs of the head as a positive means of identification was demonstrated by Drs. William L. Culbert and Frederick M. Law, of New York, when they identified an unknown body with their aid.

Heart disease occurs less frequently in children who have had their tonsils removed than in those who have not, said Dr. A. D. Kaiser, of Rochester, N. Y., before the American Medical Association.

An extract from the liver of dogs that will keep blood from clotting was discovered by Dr. W. H. Howell, of Johns Hopkins University.

A new anesthetic known as avertin that lacks many of the undesirable features of the anesthetics now in use, is being tried out in German hospitals.

The Remarkable Lincoln Science Desks



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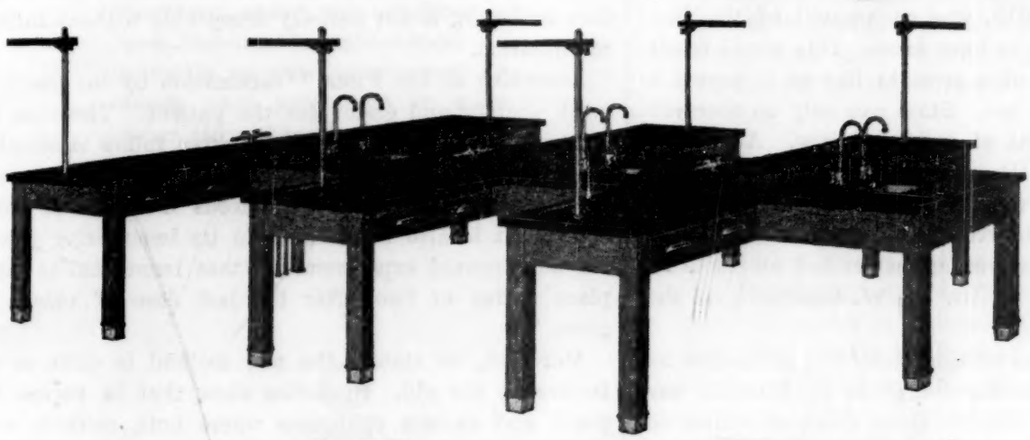

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A new and accurate chemical test for drunkenness, by which the subject's breath is passed through a chemical solution, was demonstrated to the American Medical Association by Dr. Emile Bogen, of the University of Cincinnati.

The Metropolitan Life Insurance Co. announced that their statistics showed that America has had more deaths from alcoholism since prohibition than before.

RELATIVITY

ONCE again photographic plates, exposed at the time of a total eclipse of the sun, help to substantiate the theory of relativity, as proposed by Einstein. This time it is the moon's diameter which is being measured. On plates made at the January, 1926, eclipse, which they went to Sumatra to observe, Dr. John A. Miller, director, and Dr. Ross W. Marriott, of the Sproul Observatory of Swarthmore College, find that the moon is just as large as at other times.

One of the possible experimental tests of Einstein's theory, announced in 1915, was on account of the fact that he considered light to have mass. This would result in its being pulled out of a straight line as it passed a heavy body such as the sun. Stars can only be observed near the sun at the time of a total eclipse. At such a time the stars around the sun should appear closer together than if the sun were not there. In 1919 English astronomers actually observed this effect at an eclipse visible in Brazil, and it was again verified at the Australian eclipse in 1922 by Dr. W. W. Campbell, of the Lick Observatory.

Another possible cause of this shift of star images on eclipse plates other than the one given by Einstein was proposed by Professor Charles Lane Poor, of Columbia University. He pointed out that the shadow of the moon in the earth's atmosphere during an eclipse forms a cone of cooler air. The observers are inside and as the light from the stars has to enter this cone, it might be deflected in the same way. As the edge of the moon is clearly seen during an eclipse, the light that grazes it should be similarly affected. This would mean that the moon's diameter, as measured on eclipse plates, should be less than the diameter of the moon at other times.

After unsuccessful attempts to make satisfactory plates at the eclipses in Mexico in 1923 and in New England in 1925, Dr. Miller and Dr. Marriott succeeded in 1926. A large camera, 65 feet long, with which the moon's diameter on the plate was about 7½ inches, was used. The night before the eclipse one of the plates was exposed on some stars, then, the next day, on the eclipse. The stars, their positions being accurately known, gave points from which to measure the moon's diameter.

After months of careful measurement, Dr. Miller and Dr. Marriott have found that the plates show the moon's angular diameter, as it would appear from the center of the earth, to be 2001.30 seconds, with an uncertainty of .18 second. The most accurate figure for this diameter, from measurements made at other times, is 2001.35 seconds, with an uncertainty of .1 second. As the difference, which is much less than expected by Professor Poor, is less than the uncertainty of each, Dr. Marriott has announced that there "is no measurable effect."

DR. BESREDKA'S EXPERIMENTS IN IMMUNIZATION

PILLS of dead bacilli are taken before breakfast for three days in the simple method of immunization against typhoid, dysentery and cholera now being used by people in large sections of Europe and Asia. The pills are preceded by doses of ox bile in the typhoid and cholera vaccination. This means of immunization which grew out of animal experiments made at the Pasteur Institute by Professor A. Besredka is becoming increasingly popular, according to Dr. Harry Plotz, his American assistant. It is being used extensively in France, Russia, Italy, Spain and India.

American workers in this field regard Dr. Besredka's figures as interesting and encouraging, but are of the opinion that they can not be accepted at their face value alone. Interpretation of such fundamental experiments, they maintain, is not entirely acceptable without further confirmation.

According to Dr. Plotz, "vaccination by the mouth is much simpler and easier for the patient. There are no disagreeable after-effects such as often follow vaccination under the skin and which, in the case of dysentery, proved so disastrous that the subcutaneous method was abandoned. It is also more rapid in its immunizing power. We have proved experimentally that immunization takes place a day or two after the last dose of vaccine is given."

Moreover, he stated, the new method is quite as effective as the old. Statistics show that in various typhoid and cholera epidemics where both methods were used, vaccination by the mouth was equally effective, and, in some cases, more so. Just recently Lieutenant-Colonel A. J. H. Russell, in a report to the medical section of the League of Nations, showed that he had found vaccination by the mouth and vaccination under the skin to be of equal effectiveness for cholera. He drew these conclusions after extensive vaccinations in towns in India, using both methods. Colonel Russell is director of Public Health, Madras, India. Vaccine by the mouth was given 4,982 persons. Of these 18 contracted the disease, with 4 deaths resulting. In other words, the percentage attacked was 0.36 with the deaths 22.2 per cent. of those. Among 11,004 unvaccinated controls, 222 contracted cholera and 93 died, making the percentage 2.02 attacked of which 41.9 per cent. died. Vaccine under the skin was given 8,485 persons of whom 31 contracted the disease, 2 dying. The p[illegible]entage attacked was then 0.37 and the mortality 6.5. Of 29,254 unvaccinated controls in this experiment 489 contracted the disease, 184 dying. The percentage attacked was 1.67 and the percentage of mortality 37.6.

Professor Besredka's theory, which led him to experiment with oral vaccination, is simply that it is logical to vaccinate the organ that is infected during the course of the disease. In the case of dysentery, typhoid and cholera, the germ enters by way of the mouth and pro-

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duces the disease in the small intestine. Then why not vaccinate by the mouth and emulate mother nature as much as possible? This is a far more direct way for the vaccine to reach the intestine than through the skin.

But to immunize against typhoid and cholera Professor Besredka found that it is necessary to administer ox bile first. Bile prepares the mucous membrane of the intestinal wall to receive the dead bacteria which are given by the mouth. It removes the mucous and prepares for the absorption of the vaccine which might otherwise slip through the intestinal tract. In the case of dysentery, however, the bacteria in the vaccine are capable of performing this function.

THE YIELD OF TOBACCO IN THE RIO GRANDE VALLEY

HEALTH-RESORT sun and river irrigation water combine to produce in the middle Rio Grande Valley a yield of tobacco much greater per acre than that grown anywhere else in the United States. The nicotine content of the plants is twice that of crops produced elsewhere, according to R. G. Mewborne, chemist, who is president of a local tobacco company.

The extraordinary yield in this region of the Southwest it attributed to the fact that New Mexico receives more actual hours of sunshine in a year than other sections of the country. Sufficient food from the soil in the form of potash, for which tobacco has a greater appetite than most other plants, is supplied by the waters of the Rio Grande River which irrigate the valley farms.

The Rio Grande Valley qualified as a tobacco country in a series of experimental plot tests. The heavy trial yield justified the establishment of a tobacco-growing industry in this region.

While the various smoking types of tobacco show large increases in weight per acre, a species known as rustica, whose high nicotine content was developed by the U. S. Bureau of Plant Industry, is the chief commercial crop. This tobacco, as grown in the Rio Grande Valley, has such marked insecticidal properties that it is unnecessary to extract the nicotine as is ordinarily done. The whole plant is dried, pulverized and separated into different classes of insecticidal products, some for animal parasites, particularly for dipping sheep and cattle, and others for spraying and dusting insects in orchards, gardens and farms. The supply of insecticidal nicotine in the United States was formerly limited to waste material swept up in tobacco factories.

ITEMS

HEALTH and nutrition may play a part in determining keenness of hearing, according to an investigation made by Dr. Dana W. Drury, of Boston. Using an audiometer, Dr. Drury measured the acuity of hearing of four groups of children. The best hearing was found among a group of boys in a school where care is taken to maintain high physical and nutritional standards. The next best hearing average was made by children at an institute for the blind. One hundred children from the Boston public schools average just a little lower than the blind children, and a group of children in a Massachusetts institution for state wards who are crippled and deformed had the least keen hearing of all. Of the numerous groups of different ages studied by Dr. Drury, the Harvard football squad at the close of the playing season exhibited the highest level of auditory keenness.

WHY some motormen and bus drivers have the hard luck of getting their car into accidents, while others sail along without much trouble has been investigated by two psychologists of the Personnel Research Federation. A connection between health and accidents was discovered among older drivers, the psychologists, Dr. Walter V. Bingham and C. S. Slocombe, report. Men over 50 years of age with abnormal blood-pressure had on the average more than twice as many accidents as men of the same ages and experience whose blood-pressure was normal. "It has not been generally recognized," they state, "that excessive blood-pressure, even when it is not so high as to indicate danger of a sudden collapse, may, nevertheless, be a symptom of incipient nephritis or of some systematic condition which affects general health and temperament to an extent which may seriously interfere with safe driving."

AN archeological find, throwing light on the little-known period following the withdrawal of the Roman legions from the German frontier early in the fifth century A. D., has been made by Dr. Fritz Fremersdorf, of the Wallraff-Richartz Museum at Cologne. It consists of an ancient Frankish graveyard, which was discovered during excavations in an athletic park in one of the suburbs of the city. Thus far 35 burials have been uncovered, consisting of skeletons of both men and women. The latter have articles of household gear about them, and the men are equipped with their warriors' weapons. These consist for the most part of the typical Frankish battleax, the long sword and the lance. One skeleton has the head of a long lance beside its right foot, and on the left side extending from shoulder to knee, was the blade of a magnificent sword.

DRIED whites of eggs, when included in the diet of rats, produces a curious new type of disease, Dr. Margaret A. Boas, of the Lister Institute, has found. "After two or three weeks, red scaly patches appear at the corners of the animal's mouth, the coat becomes rough and sticky, and the long hairs fall out. The red patches then spread, and the baldness increases. There are also nervous symptoms. In all cases the rats lose weight progressively and soon die, although rats on the same diet, but with fresh instead of dried egg-white, live quite contentedly in perfect health." Dr. Boas does not consider that the disease is caused by a toxic substance, but believes that it is due to the deficiency of some essential food factor which is probably destroyed when the egg-white is dried. The dried egg-white can be rendered quite harmless, she has found, by adding some other substances to the diet, such as potatoes or arrowroot.